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ANNUAL REPORT

OF THE

State Engineer and Surveyor

ON THE

CANALS OF THE STATE.

TRANSMITTED TO THE LEGISLATURE JANUARY 2, 1878.

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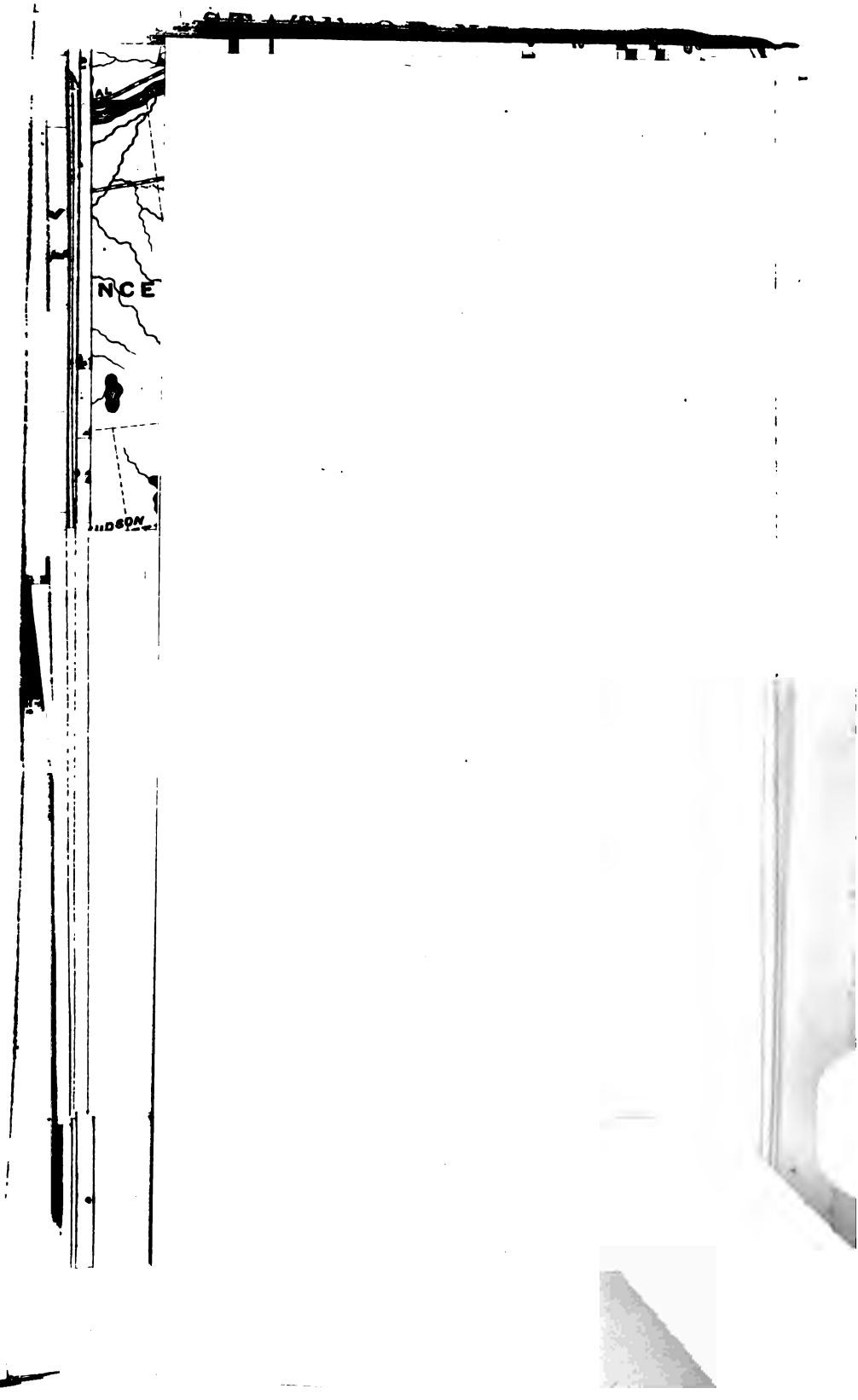
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STATE OF NEW YORK.

No. 9.

IN ASSEMBLY,

ALBANY, *January* 2, 1878.

ANNUAL REPORT

OF THE

STATE ENGINEER AND SURVEYOR ON THE NEW YORK STATE CANALS, FOR THE FISCAL YEAR ENDING SEPTEMBER 30, 1877.

OFFICE OF THE STATE ENGINEER AND SURVEYOR,
ALBANY, *December* 31, 1877.

Hon. HORATIO SEYMOUR, Jr., *State Engineer and Surveyor:*

SIR. — I herewith inclose for transmission to the Legislature, the annual report of the State Engineer and Surveyor on the Canals of the State, for the year ending September 30, 1877.

Yours, respectfully.

JOHN D. VAN BUREN, JR.,
State Engineer and Surveyor.

OFFICE OF THE STATE ENGINEER AND SURVEYOR,
ALBANY, *January* 2, 1878.

Hon. JAMES W. HUSTED, *Speaker of the Assembly:*

SIR. — I have the honor to transmit herewith, to the Legislature, the annual report of my predecessor, Hon. John D. Van Buren, Jr., on the canals of the State, for the year ending September 30, 1877.

Yours respectfully.

HORATIO SEYMOUR, JR.,
State Engineer and Surveyor.

ERRATA.

Page 60, table, 4th column: for 139,98.4, and 146.2, read 455.92, 322.75, and 479.54, respectively. In 5th and 6th columns omit the decimal marks.

Page 61: for 12,758,606 read 12,758,999.

Page 62, last paragraph: omit quotation marks.

annual report for the fiscal year ending September 30, 1877.

Engineer Department.

The engineer force has been kept down to the lowest limit compatible with the proper discharge of the duties imposed by law on the State Engineer and Surveyor. At the date of this report there are but three assistants of all grades employed on each of the three divisions of the canals; and the running expenses will be covered by the appropriation of $30,000 made from the ordinary repair fund.

In 1875 the number of assistants of all grades varied from thirty-one to one hundred and one, and averaged about sixty per month employed on works of "extraordinary repairs" — works which, for the most part, were not necessary to good navigation or the preservation of the canals. The reduction of the engineering force during the past two years is, of course, largely, but not entirely, due to the cessation of works of "extraordinary repairs."

The following table exhibits the expenditures for engineering during the past fiscal year.

Summary of Engineering Expenses for the Year ending September 30, 1877.

	Ordinary repair fund.	Champlain canal enlargement.	Extraordinary repair fund.	Survey of Erie canal.	Totals.
Eastern division	$8,027 89	$2,424 50	$5,085 32	$1,016 87	$16,554 58
Middle division	8,818 35	.....	2,634 50	2,401 61	13,854 46
Western division	8,446 65	.....	330 00	2,516 22	11,292 87
Totals	$25,292 89	$2,424 50	$8,049 82	$5,934 70	$41,701 91

Of the amount expended from the extraordinary repair fund $2,306.50 was for surveys and examinations called for by the Attorney-General in connection with pending suits.

The expenses of engineering for the past six years have been as follows:

1872	$110,149 33
1873	96,184 80
1874	104,199 23
1875	144,479 00
1876	66,240 65
1877	41,701 91

It will be observed that the annual expenditure has been $41,701.91, of which $16,409.02 was for special objects. At the date of this report the rate of expenditure is, as already stated, limited to about $30,000 per annum.

The duties of the reduced force of engineers have been arduous. The following are the works upon which they have been engaged: completion of the survey of the Erie canal; revision of estimates and preparation of plans for the enlargement of the Champlain canal; completion of the Oneida Lake canal; rebuilding bridge abutments and locks on the Champlain canal; the supervision of ordinary repairs; the making of surveys and maps for the canal appraisers; the settlement of old contracts under act chapter 425, Laws of 1876, besides ordinary and general routine duties.

The State Engineer and Surveyor deems it his duty, as it is his great pleasure, at the close of his term of office, to commend the engineers generally for the faithful and skillful manner in which they have fulfilled their duties. It has been necessary to dispense with the services of many young engineers who have proved themselves, both in the preliminary examinations to which they were subjected before appointment and by faithful service afterwards, to be well qualified professionally, and in every respect worthy of confidence.

It is recommended that an appropriation equal to that made last year from the ordinary repair fund, of $30,000, be made for the coming year to cover engineering expenses.

CANALS.

The State canals, for convenience in construction and the superintendence of repairs, are divided into three divisions, eastern, middle and western; each under the charge and supervision of a Canal Commissioner, a division and resident engineer.

EASTERN DIVISION.

Names of canals.	Miles.
Erie canal, Albany to Utica	106.243
Albany basin	.77
Port Schuyler and West Troy side-cut	.35
Mohawk feeder (north side), Little Falls	.50
Champlain canal, including Waterford side-cut, and Cohoes and Saratoga dams	66.00
Pond above Troy dam	3.00
Glens Falls feeder and pond	12.00
Total miles	188.863

The engineering of this division has been in charge of E. Sweet, Jr., as division engineer, and Bryant Godwin, as resident engineer.

MIDDLE DIVISION.

Names of canals.		Miles.
Erie canal, from east line of Oneida county to east line of Wayne county		97.02
Limestone feeder, Erie canal to Fayetteville	.80	
Butternut feeder, Erie canal to Dunlap's mills	1.55	
Camillus feeder, Erie canal to Camillus	1.00	
		3.35
Oneida Lake canal, Durhamville to Oneida lake		5.00
Oswego canal, Syracuse to Oswego		38.00
Cayuga and Seneca canal, Montezuma to Cayuga and Seneca lakes		22.77
Chenango canal, Utica to Binghamton		97.00
Ithaca inlet, Cayuga lake to Ithaca		2.00
Baldwinsville canal, improvements to Jack's reefs		12.50
Seneca River towing-path, Baldwinsville to Mud lock		5.75
Oneida River improvements, Oswego canal to Oneida lake,		20.00
Black River canal		35.33
Black River feeder, and pond above dam		12.09
Delta feeder		1.38
Black River improvement		42.50
Total miles		394.69
Chenango extension — not in use		30.00

This division has been in charge of Charles A. Sweet, as division engineer, and Denison Richmond, as resident engineer.

WESTERN DIVISION.

Names of canals.	Miles.
Erie canal, from east line of Wayne county to Buffalo.....	148.90
Genesee Valley canal, from Rochester to Mill Grove.....	113.50
Dansville branch of Genesee Valley canal	11.00
Genesee River feeder, at Rochester.....	2.25
Genesee River feeder, at Oramel.....	.75
Crooked Lake canal, Seneca lake to Crooked lake	8.00
Chemung canal, Watkins to Elmira.....	23.00
Chemung canal feeder, Horseheads to Corning	16.00
Total miles	323.40

This division has been in charge of William H. Searles, as division engineer throughout the year, with Byron M. Hanks as resident engineer, until his death, May twenty-one, and Thomas Evershed, from June twelfth, until the end of the fiscal year.

ORDINARY REPAIRS.

Ordinary repairs are executed by the superintendents, who, although appointed by the Canal Board, act, as a rule, under the sole directions of the Canal Commissioners.

The following statements show the cost of such repairs for the three past years:

	1875.	1876.	1877.
By superintendents.....	$893,432 92	$810,707 01	$765,382 94
By Canal Commissioners.....	272,059 69	196,652 94	52,396 80
By division engineers.....	.....	*8,694 64	25,292 89
Total.....	$1,165,492 61	$1,016,054 59	$843,072 63

In order to avoid confusion it must be borne in mind that the figures given in the auditor's financial report, do not, and generally cannot, agree exactly with the statements of actual expenditures for repairs belonging to a particular year. Some accounts belonging to one year are necessarily bridged over until the next; temporary advances are made by banks to the superintendents to cover temporary

*Previous to June, 1876, paid by Canal Commissioners.

deficiencies in the revenues, which do not appear in the accounts until several months after they are made; and balances remaining in the hands of the superintendents are included as payments. In order to arrive at a correct statement of the expenditures properly chargeable to a particular year, the items of expenditures must be examined. The tables in the appendix, exhibiting the cost of ordinary repairs done by the superintendents, to which attention is respectfully invited, have been carefully prepared, under the direction of the State Engineer and Surveyor, from their original abstracts, and accurately represent the cost of such repairs, belonging to the respective years stated.

An examination of the details of these expenditures will be of service in determining what further reduction in the cost of such repairs can be made.

The total expenditures for ordinary repairs made by the superintendents for all the canals for the past fiscal year are as follows, the figures for the four canals which are to be abandoned at the close of the season of navigation in 1878, being separately stated:

	For all canals.	For Genesee Valley, Chem'g, Chenango, and Crooked Lake canals.	For canals which are to be retained.
Lock tending	$107,996 14	$11,547 14	$96,449 00
Labor	881,337 75	35,848 43	345,489 32
Materials	164,153 40	8,471 44	155,681 96
Merchants and mechanics	59,881 12	2,216 65	57,664 47
Miscellaneous	8,267 57	293 09	7,974 48
Clerk hire	16,388 14	950 00	15,438 14
Superintendents for salaries	26,898 31	2,412 48	24,485 83
	$764,922 43	$61,739 23	$703,183 20
Add allowances by auditor	460 51	.....	502 51
Less disallowances by auditor	.....	42 00	.....
Total	$765,382 94	$61,697 23	$703,685 71

It appears from this statement that at least $61,697.23 will be saved by the abandonment of these four canals, in these items alone.

Of the items of expenditure relating to the canals which are to be retained, the following cannot be materially reduced, even under a new system of management: lock-tending, superintendents for salaries, and clerk hire; these admit of a definite estimate. There remain, therefore, the items: labor, $345,489.32, and materials and merchants' and mechanics' bills, $213,346.43, which are variable and, without doubt, can be materially reduced by improvement in canal management. How much the item of labor can be reduced it is very difficult to determine; but that a substantial reduction can be made is undoubtedly true.

The following remarks, taken from the last annual report, cover the question of purchases of tools and materials, or "materials," "merchants'" and "mechanics'" bills:

* "The State Engineer and Surveyor has had occasion to examine a large number of superintendents' returns, and is convinced that the State has suffered and continues to suffer great loss in the purchase of tools and materials, on account of the high and extravagant prices allowed. There is now no general system controlling these purchases; each superintendent trades independently with merchants of his own selection, and it often occurs that the prices allowed for precisely the same kind and quality of articles, on adjacent or neighboring sections, vary as much as fifty per centum.

The purchase of tools and materials should be controlled by a general system, providing that they shall be made by a single or central authority, and by contract with the lowest bidder, or in some way that will secure the lowest prices.

With the data at hand, there is no difficulty in making close estimates of the necessities of a season; and there is no doubt that, by adopting such a system, from forty to fifty per centum could be saved to the State on the purchases as now made. The purchases by the superintendents now annually amount to about $200,000; and have in previous years amounted to nearly $300,000. As these purchases are now generally made, the State pays not the lowest market price, but the prices asked by the local merchants. Annual contracts could be made for the delivery of articles along the line of the canal when and where wanted, and sufficient supplies for daily use and emergencies could be kept stored in the various State shops. Whatever system is pursued in making these purchases, great improvement is clearly necessary in this branch of canal management. A system of strict accountability for all tools and materials purchased or received by officials having charge of repairs should be inaugurated.

Attention is also called to the manner of making repairs to the *structures* of the canals. It has often occurred that extensive repairs, requiring careful engineering supervision, have been carried on without consultation with the engineer department. In order to secure safe, durable and cheap work, it should be *provided by law* that no repairs to any structure on the canals shall be made without the supervision of an engineer."

It is the opinion of the State Engineer and Surveyor that at least $150,000 can be saved in the items of the above table.

*From report of 1876.

The following statement includes all the expenditures, properly belonging to the operations of the past fiscal year, made from the ordinary repair fund, for managing the canals:

By Canal Commissioners	$52,396 80
Superintendents	765,382 94
Division engineers	25,292 89
For collectors and inspectors	55,565 43
Weighmasters	9,827 69
Miscellaneous, salaries of officers and refunding of tolls	56,234 67
Total	$964,700 42

If a reduction is made from this amount, on account of the abandonment of the lateral canals, of $61,739.23 and $150,000 for improved economy in the future, or a total of $211,739.33, there remains $752,961.09 as the sum absolutely required to properly manage the canals which are to be retained after the close of navigation in 1878. Nothing is allowed for the laterals which are to be abandoned, for the months of October and November next, because they will be practically out of the system before October, if they are to be abandoned as is contemplated by the statute.

It must be observed also that $73,271.29 were expended during the past fiscal year for works of special repair under the designation of "extraordinary repairs." These repairs were, strictly speaking, *special ordinary repairs*, and should have been paid for out of the ordinary repair fund, had the tolls been sufficient. The amount required for such purposes during the fiscal year commencing October 1, 1877, will not be less than this amount, say $75,000; these repairs, however, should be provided for from the revenues of the canals. The sum absolutely required to manage the canals, is therefore estimated to be $827,961.09, without allowing for such contingencies as breaks.

It is the opinion of the State Engineer and Surveyor that the sum of $900,000 per annum is the lowest estimate that should be adopted in providing for the future wants of the canals. This is just within the amount of the gross revenues of the past fiscal year *$1,041,690.66, which is the constitutional limitation of the expenditures for the constitutional canals for "collections, superintendence, ordinary and extraordinary repairs," for the year commencing October 1, 1877.

* From Auditor's Report.

The general condition of the constitutional canals has been much improved, and good navigation has been maintained on them during the season, which has been exceptionally free from serious detentions on account of breaks. A review of the operations of the year shows considerable improvement in the management of the repairs.

For the details of such works of ordinary repair as have been executed under the supervision of the engineer department, reference is made to the reports of the division engineers hereto annexed.

EXTRAORDINARY REPAIRS.

* "Under this designation it has been customary to class all unusual repairs to and changes in the canals and their important structures. Provision for the cost of these works has heretofore been made by special appropriation of funds raised by general taxation. All repairs necessary to maintain the canals in an efficient condition should be classed as *ordinary repairs*, and paid for out of the canal revenues; which, under an economical administration are, even now, ample for the purpose.

"Large appropriations have heretofore been annually made for special local improvements not necessary for the purposes of navigation, nor adding in any degree to the efficiency of the canal system. The State is in no wise bound to provide for any such improvements. The expenditures for these purposes have been charged against the canals, and, but for them, their present financial condition would be much more satisfactory than it now is. The expenses of such improvements should be borne by the communities or parties specially interested, and not by the State."

In view of the financial difficulty of the canals, the State Engineer and Surveyor has, in the many cases referred to him, or calling for his judgment, advised against the expenditure of any money for works of "extraordinary repairs" and local improvements not absolutely necessary to good navigation, or the proper maintenance of the canals, notwithstanding the existence on the statute books of unexpended appropriation for such objects. His views in this respect have uniformly met the approval of the executive department and the Canal Board.

The following is a complete statement of the expenditures for special repairs, under act chapter 425, Laws of 1876, and the laws providing for the completion of the Oneida Lake canal, for the years 1876 and 1877, exclusive of the cost of engineering.

* From report of 1876.

Appropriations by act chapter 425, Laws of 1876, $135,000, and $6,000. Fund for the completion of the Oneida Lake canal, $48,810.70.

Under resolutions of the Canal Board.

DESCRIPTION OF WORK.	Appropriation by Canal Board.	Expenditure.
DURING FISCAL YEAR ENDING SEPTEMBER 30, 1876.		
Wooden dam at Phœnix	$4,000 00	$2,344 00
Wooden dam at Fulton	6,000 00	*5,173 90
Wooden dam at Van Buren	8,000 00	*5,548 02
Wooden dam at Minetto	3,000 00	*2,169 13
Wooden dam at Troy	7,500 00	*5,991 17
Breakwater at Black Rock	15,000 00	12,132 22
Total, 1876	$43,500 00	$33,358 44
DURING FISCAL YEAR ENDING SEPTEMBER 30, 1877.		
Wooden dam at Oneida	$4,200 00	$1,446 36
Wooden dam at Fayetteville	2,100 00	.....
Wooden dam at Jordan	1,100 00	125 59
Bridge abutments, Champlain canal	32,241 00	19,583 12
Culverts at Crescent and near lock number 24	6,316 52	6,316 52
Lock 6, Champlain canal	15,140 76	15,140 76
Liberty street bridge Schenectady	2,423 61	2,423 61
Bridge at Port Schuyler	3,594 60	3,596 45
Bridge at Exchange street, Albany	1,479 50	1,307 67
Two sewers at Utica	6,000 00	5,539 85
Completion of Oneida Lake canal	18,000 00	17,791 36
Total, 1877	$92,595 99	$73,271 29
Total, 1876	43,500 00	33,358 44
Total for 1876 and 1877	$136,095 99	$106,629 73

Total amount done in 1877, $73,271.29.

For the completion of the highway road-bridge, in the town of Pittsford (under act chapter 425, Laws of 1876) there has been expended during the past fiscal year, under act chapter 425, Laws of 1876, the sum of $853.31, which, added to the above, makes a total, for extraordinary repairs done during the fiscal year, of $74,124.60.

The above works have all been completed with the exception of the bridge abutments on the Champlain canal and three feeder dams at Oneida, Fayettville and Jordan, which are still in progress. It will be observed that the completed works have generally cost less than the estimate or sum originally set apart by the Canal Board, notwithstanding the fact that on the Oswego dams considerably more work was done than was covered by the original estimates. The following remarks on the Oneida Lake and Champlain canals, include detailed statements relating to the more important of these repairs which were made during the past fiscal year:

COMPLETION OF THE ONEIDA LAKE CANAL.

The payments on account of the construction of this canal, from its commencement, in 1867, to the final suspension of contract work

* Work done in 1876, payments made in 1877.

in January, 1875, have been $386,673.05. In April last, by direction of the Canal Board, plans and estimates were submitted for completing this work, so as to give either five or seven feet of water. These estimates were as follows:

For completion with five feet	$18,000 00
For completion with seven feet	20,100 00
For full completion on original plan	36,000 00

On the tenth of April the estimate was approved and the work ordered to be done. Work was at once begun under the joint supervision of the Commissioner in charge and the State Engineer, and was finished in September.

As completed, there are seven feet of water on the first level, and five on the remaining levels. No new slope walls were built.

The total cost of completing this canal, pursuant to resolution of the Canal Board, adopted April 10, 1877, was:

For labor	$10,833 55
For materials	6,957 81
For engineering	859 50
Total	$18,650 86

In addition to the above, the sum of $1,161.00 has been expended for surveys and maps of the completed canal, and for surveys and maps for the board of canal appraisers, not connected with the work of construction. Upon admitting water to this old canal serious defects in the execution of the contract work, which could not have been detected otherwise, disclosed themselves. The banks, although constructed several years ago, and having had abundant time to become thoroughly settled, leaked in many places. The second lock above the Oneida lake terminus of the canal, leaked so badly that it was deemed unsafe to retain the water. The water was accordingly withdrawn from the two northern levels, and steps taken to repair the lock referred to.

Upon sinking pits in the rear of the berme wall and breaking into the wall, it was found to consist of two shells of rubble masonry in poor cement, with a filling of small, loose stones which could be readily removed by hand.

It is sufficient to say, in regard to the character of the masonry of

this lock, that grout poured in near the top of the rear of the wing wall, at a point about ten feet below the lower hollow quoin, made its appearance through the face of the lock wall, near the bottom, and at a point *fifty feet* above the point where it entered.

After thoroughly grouting this wall, in which over 2,000 bushels of cement were used, water was again admitted; since which time the lock has given no trouble.

Subsequently two breaches occurred in the banks, which have been repaired, and the canal is now in fair condition and in use for purposes of navigation. The total cost of this canal, to the close of the last fiscal year, has been:

Under contracts, dated December 18, 1867	$350,509 54
Under contracts, dated December 19, 1873	36,163 51
Under resolution Canal Board, adopted April 10, 1877,	17,791 36
Total (exclusive of engineering)	$404,464 41
Total engineering since 1866	39,691 23
Grand total	$444,155 64

CHAMPLAIN CANAL.

This canal has been maintained in fair navigable condition. During the past season three breaches have occurred: one at Stillwater, one at Coveville and one at Glen's Falls. The suspension of navigation in consequence of these breaches was about twenty-four hours in each instance.

Early in the year careful estimates, plans and specifications were prepared for improving the condition of this canal by raising and strengthening its banks so as to give six feet of water, and by renewing or improving its mechanical structures. These plans, estimates and specifications were submitted to the Canal Board, but, on account of the constitutional limitation of expenditures, the work was not authorized.

In December, 1876, however, estimates for rebuilding bridge abutments and for rebuilding one of the walls of lock 6, north of Waterford, were submitted to the Canal Board, and that body authorized the expenditure from a fund appropriated by the Legislature, by act chapter 425, Laws of 1876, and directed the prosecution of the work under the joint supervision of the commissioner in charge and the State Engineer and Surveyor.

The estimated cost of these works was as follows:

For rebuilding bridge abutments	$32,241 00
For rebuilding lock 6 *	10,719 50
Total	$42,960 50

The sums actually expended were:

For rebuilding lock 6 *	$15,140 76
For rebuilding bridge abutments	19,583 12
Total	$34,723 88

The work upon the bridge abutments is not yet completed. Thus far, forty-seven abutments have been entirely, and seven partially, rebuilt. The materials have nearly all been delivered for the completion of the entire work. The State Engineer has endeavored to secure, in all of this work, faithfully constructed and substantial rubble masonry. The work has been constantly under the supervision of competent and trustworthy assistants who, although they have had more or less difficulty in securing a proper execution of the work by the masons, have succeeded in producing unusually good results.

Nearly all of the mechanical structures on this canal, except such as have been recently rebuilt, are in a very dilapidated condition and need extensive repairs. The State Engineer is of opinion that all of these structures, which have not been already provided for, may be gradually put in good condition by a judicious and economical use of the usual appropriation for ordinary repairs.

For further and detailed information in relation to the Champlain canal reference is made to the report of the division engineer of the eastern division.

SURVEY OF THE ERIE CANAL.

At the date of the last annual report the field-work of the survey of the Erie canal authorized by act chapter 425, Laws of 1876, had been nearly completed. During the last fiscal year this survey has been completed and cross-sections plotted in uniform books for permanent preservation in the office of the State Engineer. The field books have been put into permanent form and will be preserved in the office of the respective division engineers, where they will supply a want long felt, of a permanent and complete record of the

* See report of division engineer of eastern division.

condition of the Erie canal, of the length and elevation of its levels, of the location of its mechanical structures, and of the condition of its banks.

These records, besides serving for purposes of reference, will be of great value as a trustworthy basis of estimate for future improvements, or for the ordinary repairs which may be necessary from time to time, to properly maintain the banks of the canal.

The waste-weirs generally are found to be considerably below the standard elevation, and the result is a large loss of water. These defects should be remedied as soon as possible by raising the crests to the standard heights and every precaution should be taken to prevent both waste and unauthorized use of water.

It will be observed that the division engineers report, that at no point did they find less than seven feet of water in the middle of the canals, but that they have found deposits near the sides, which have, in many instances, reduced the depth of water considerably below the standard.

The original appropriation for this survey was $15,000. Of this sum there was expended, during the fiscal year ending Sept. 30, 1876, the sum of $9,078.61. During the past fiscal year, the expenditures were $5,909.64; making a total expenditure of $14,988.25, and leaving an unexpended balance of eleven dollars and seventy-five cents.

For the details of this survey, reference is made to the accompanying reports of the division engineers.

SETTLEMENT OF CONTRACTS UNDER ACT CHAPTER 425, LAWS OF 1876.

Very few of these old contracts now remain unsettled, under act chapter 425, Laws of 1876. As stated in the last report the recommendations made in each case in the special report on contracts to the Canal Board, June 8, 1876, were founded upon engineering considerations only, without reference to the questions of law or policy involved; they left the matter of compromises entirely to the judgment of the Canal Board.

Many difficult questions have been involved in these cases, such as the following: the extent to which the State is bound by the acts of its engineers in accepting inferior work; the degree of reliance which can be placed upon the recorded measurements and notes of the engineers — the only data available in many cases; was the acceptance of inferior work a case of *fraud* or *neglect* on the part of the engineers; would it be profitable to litigate the claims, or would litigation result in substantial success, or the recovery of a sum equal to the cost

of the suit? Of the disputed items in these cases by far the larger portion in amount related to the quality of the work done and materials delivered and accepted by the State's agents. The contractors claim that the objections come in now too late, and should have been made when the work was in progress, in order to afford them an opportunity to remedy the defects at small cost or to throw up their contracts.

The consideration of these questions and many special circumstances connected with each case have necessarily modified the purely engineering views expressed in the report referred to; and in the cases settled it has, in the judgment of the Canal Board, been for the best interests of the State to compromise the claims, upon getting substantial reductions from them, although such reductions were, in many cases, less than the reduction which would seem to be proper in a strictly engineering view. Besides the reductions made from the original claims of the contractors they have, except in undisputed cases, been allowed no interest. In some cases the contracts, which were for wholly unnecessary work, were canceled and the work stopped before much progress had been made, and large sums, in addition to the reduction from the claims for the work already done, have in this way been saved.

Of the sums paid in settlement of these contracts, $56,566.46 relate to undisputed cases, and $106,219.47 to disputed claims, making a total of $162,785.93, including interest. The aggregate reduction made amounts to $30,847.64. Forty contracts have been settled and fourteen remain for settlement. Those remaining for settlement include the larger claims against the State, most of which are in litigation.

LIST of contracts settled by Canal Board under act chapter 425, *Laws of* 1876.

1876.

Number.	Name.	WORK.	Act of Legislature.	Claim of Contractor.			Final payment ordered by Canal Board in settlement, without interest.	Total payments by auditor; or amount of final account approved by Canal Board.	Reductions.
				Final account as estimated by former engineers.	Legal interest.	Total amount of contractor's claim.			
1355..	John Brown	Whipple iron bridge at Menand's road.....	766 of 1873..	$13,063 05	$151 56	$13,214 61	$2,000 00	$12,164 56	$1,050 05
1217..	John Phelan...	Wire bridge over Erie canal at lumber district, Albany, near lock 2.....	767 of 1870..	2,543 80	55 67	2,599 47	1,343 80	2,599 47	.....
1397..	James Vickerman...	Dam on Owasco outlet at Auburn..... ..	399 of 1874..	6,936 15	.....	6,936 15	1,887 15	6,936 15	. .....
1300..	Clark & Bennett....	Protecting canal against encroachment of Lake Erie	767 of 1870..	151,351 94	1,147 33	152,499 27	13,987 20	152,499 27	.....
1401..	A. M. Ross.....	Wrought iron bridge south St. Paul street, Rochester.....	766 of 1873..	7,419 17	53 12	7,472 29	1,146 17	7,472 29	....
1337..	E. B. Van Dusen....	Improving and deepening Erie canal, between Thomas Creek culvert and Macedon locks,....	766 of 1873..	9,230 89	.....	9,230 89	1,580 89	9,230 89	.....
1343..	John Brown	Stone abutment to bridge at Hulser's farm, West Frankfort.....	850 of 1872..	1,560 00	....	1,560 00	113 98	1,439 98	120 02
1368..	John Brown	Iron bridge at Exchange street, Albany.....	399 of 1874..	7,400 00	.....	7,400 00	574 61	6,864 61	535 39
1376..	Daniel P. McQueen.	Tree dam across Moose river, Black River canal..	399 of 1874..	1,619 74	.....	1,619 74	1,193 96	1,193 96	425 78
1306..	Charles Nichols.....	Removing wall-bench and constructing slope wall from sluice east of Kast's bridge to Nourse's cut, Erie canal...	766 of 1873..	11,770 13	... .	11,770 13	600 00	9,865 00	1,905 13
1307..	Charles Nichols....	Removing wall-benches and constructing slope wall from Frankfort locks to section 102.....	766 of 1873..	13,488 16	.....	13,488 16	1,900 00	12,780 00	708 16
1398..	E. B. Van Dusen....	New feeder channel at Port Byron.....	399 of 1874..	14,892 24	... .	14,892 24	3,060 24	14,892 24	....
1292..	Henry J. Mowry	Deepening and improving Erie canal, from Buffalo to Black Rock.....	850 of 1872..	351,161 63	3,628 43	354,790 06	46,839 69	341,158 12	13,631 94
1297..	E. B. Van Dusen....	Removing remains of State dam on Scajaquada creek	766 of 1873..	599 00	.....	599 00	89 00	599 00	.....
					$5,086 11		$76,306 69		$18,376 47

The following certificates for work outstanding, provided for by act chapter 263, Laws of 1875, and act chapter 425, Laws of 1876, have been paid, and the contracts settled:

		Interest.
1208. Willard Johnson, December 22, 1871, on Jason Street bridge, Utica.....	$516 92	$73 75
1320. Dana Reed, October 29, 1873, sewer at West Troy..... ...	3,195 49	409 77
1314. A. J. Brown, October 29, 1873, for bridge at Alexander street, Cohoes,	327 05	40 99
1209. E. B. Van Dusen, December 22, 1871, for bridge at Columbia street, Cohoes,	1,110 00	117 87
1313. J. M. Barnett, October 16, 1873, for extending abutments, East Frankfort,	806 17	62 93
1022. A. J. Brown, September 9, 1869, for wooden road bridge, with sidewalk, at Ilion.....	1,605 40	123 15
	$7,561 03	$828 46

LIST of contracts settled by Canal Board under act chapter 425, *Laws of* 1876.

1877.

Number.	Name.	WORK.	Act of Legislature.	Claim of Contractor.			Final payment ordered by Canal Board in settlement without interest.	Total payments by auditor, or amount of final accounts approved by Canal Board.	Reductions.
				Final account as estimated by former engineers.	Legal interest.	Total amount of contractors' claim.			
1377..	John McEncroe, Jr..	Slope and vertical wall, tow-path side, Erie canal, from lock 22 to 23, 40 chains	399 of 1874..	$3,186 60	.....	$3,186 60	$237 28	$3,127 28	$59 32
1378..	John McEncroe, Jr..	Slope and vertical wall, tow-path side, Erie canal, from lock 25 to 26, 60 chains	399 of 1874..	412 27	.. ..	412 27	329 82	329 82	82 45
1379..	John McEncroe, Jr..	Slope and vertical wall, tow-path side, Erie canal, from lock 29 to 30, 80 chains	.....	11,828 16	.....	11,828 16	2,157 73	11,286 73	541 43
1233..	Melvin A. Nash.....	Enlargement Champlain canal, part section 30 and all of section 31, second division enlargement survey	788 of 1870..	106,395 30	.....	106,395 30	10,960 30	101,395 30	5,000 00
1384..	P. Haggerty (assignee to J. McEncroe, Jr.)	Slope and vertical wall, tow-path side, lock 27 to 28, 40 chains	399 of 1874..	3,305 75	.....	3,305 75	372 00	3,007 00	298 75
1371..	Daniel Candee.....	Vertical wall, 300 chains west lock 32 to 33, Erie canal	399 of 1874..	7,525 63	.....	7,525 63	1,033 70	7,254 70	270 93
1372..	Daniel Candee.....	Vertical wall from lock 31, Erie canal, west 120 chains	399 of 1874..	3,446 45	.....	3,446 45	390 76	3,348 76	97 69
1373..	Daniel Candee.....	Slope and vertical wall, 720 chains west of lock 31 to lock 32, Erie; 120 chains, tow-path side	399 of 1874..	5,158 03	.....	5,158 03	522 42	5,027 42	130 61
1370..	Daniel Candee.....	Vertical wall at Ilion and Frankfort	399 of 1874.	1,418 17	. .....	1,418 17	168 94	1,375 94	42 23
1329..	Van Vranken & McEncroe.....	Constructing vertical wall at locomotive works, Schenectady	.....	1,767 56	.....	1,767 56	426 00	1,650 00	117 56
1235..	E. B. Van Dusen....	Cribs and vertical wall at Tonawanda	850 of 1872..	97,207 17	$572 23	97,779 40	7,207 17	97,779 40	.....
1340..	Henry D Denison...	Rebuilding lock on Glen's Falls feeder	766 of 1873..	39,000 00	1,589 96	40,589 96	13,603 73	40 589 96	.....
1381..	N. L. Osborn.....	Enlargement Champlain (station 50 to station 99), first division	*399 of 1874.	15,239 76	.....	15,239 76	2,420 38	15,000 38	
1382..	N. L. Osborn.....	Enlargement Champlain (station 135 to station 190), first division	*399 of 1874.	19,749 96	... .	19,749 96	5,998 68	19,156 68	1,000 00
1380..	N. L. Osborn.....	Enlargement Champlain canal, station 0 to station 50, first division	*399 of 1874..	10,711 50	.. ..	10,711 50	1,602 16	10,544 16	

List of contracts, etc. — (Continued).

Number.	Name.	WORK.	Act of Legislature.	Claim of Contractor.			Final payment ordered by Canal Board in settlement without interest.	Total payments by auditor, or amount of final accounts approved by Canal Board.	Reductions.
				Final account as estimated by former engineers.	Legal interest.	Total amount of contractors' claim.			
1374..	Flagler & Reilly	Slope and vertical wall from lock 32, at Fort Plain west 100 chains, tow-path side.	†399 of 1874..	$30,343 90	‡ $1,718 49	$32,062 39	$10,708 78	$28,864 78	$3,197 61
1375..	Flagler & Reilly	Slope and vertical wall, from lock 28 to 29, 100 chains, tow-path side.....	†399 of 1874..	9,935 57	‡158,97	10,094 54	1,291 22	9,757 23	337 32
1364..	Horace Candee.. ...	Slope wall on the Jordan level.....	399 of 1874..	68,905 34	.....	68,905 34	10,557 07	67,694 07	1,211 27
1363..	Beckwith & Ford ..	Highway road bridge, town Pittsford.....	399 of 1874..	2,553 31	.....	2,553 31	853 31	2,553 31	.....
1385 .	Henry J. Mowry ...	Slope and vertical wall, berme side, at Port Gibson.....	399 of 1874..	560 00	.....	560 00	.....	476 00	84 00
					$2,162 19		$70,891 45		$12,471 17

* Act chapter 185, Laws of 1876. † Act chapter 270, Laws of 1875. ‡ Not allowed.

Final payments ordered by Canal Board, with interest, 1876	$89,732 29
Final payments ordered by Canal Board, with interest, 1877	73,053 64
Total	$162,785 93
Reductions, 1876	$18,376 47
Reductions, 1877	12,471 17
Total	$30,847 64

UNSETTLED CONTRACTS.

TABLE No. 1.

Extraordinary repair contracts made since January 1, 1868. Final approved prior to January 1, 1876.

EASTERN DIVISION.

Number.	Name.	Date.	WORK.	Act of Legislature.	Appropriation.	Engineer's estimate.	Engineer's estimate at contract prices.	Final account.	Payment by the auditor.
1024..	J. V. Boomer.....	Oct. 15, 1865..	Constructing the lower lock at the upper side-cut, West Troy.....	263 of 1875 579 of 1867	$69,274 32	$49,026 00	$38,286 00	$111,197 99	§ $61,761 00
1369..	John and Val. Brown...	Oct. 20, 1874..	Slope and vertical wall, 200 chains west of lock 22, Erie canal, west 100 chains	399 of 1874	.....	16,000 00	7,105 00	26,940 33	26,792 00
1009..	Henry D. Denison	Sept. 9, 1869..	Removing and constructing wall from lower Mohawk, west half mile, and from lock 19 to 20	877 of 1869	40,953 00	35,490 00	23,405 00	50,703 60	40,953 00
1360..	J. V. Quackenbush	Sept. 8, 1874..	Whipple iron bridge at Mohawk.....	766 of 1873	*7,500 00	7,500 00	3,390 00	17,087 43	4,182 00
383..	J. C. Smith	Oct. 20, 1874..	Slope and vertical wall, tow-path side, lock 30 to 31, 20 chains	399 of 1874	.....	3,000 00	831 50	3,757 90	3,196 00
			MIDDLE DIVISION.						
1304..	Thomas Gale	Aug. 18, 1873..	Slope wall on tow-path side, Jordan level....	766 of 1873	$38,000 00	$38,000 00	$21,060 00	$21,916 99	$17,406 00
1351..	S. D. Keller..... ...	April 22, 1874..	Vertical wall between Warren street and west end of weigh-lock basin, Syracuse....	766 of 1873	†4,197 50	4,197 50	2,741 25	575 34	221 00
1400..	Howard Soule, Jr.....	Dec. 8, 1874..	Swing-bridge at Salina street, Syracuse.....	....	.....	23,000 00	17,255 00	15,190 19	.....

* Reappropriation vetoed.

† Reappropriation vetoed, 1875.

§ Certificate for final, $49,436.99.

Certificates for work outstanding and provided for by chapter 263, *Laws of* 1875, *and act chapter* 425, *Laws of* 1876.

1299.	J. M. Barnett, August 19, 1873, for walls, etc., Ferguson's aqueduct	$26,988 39
1276.	H. J. Mowry, December 18, 1872, for dam at Cazenovia	9,740 61
	S. D. Keller, for taking down and relaying retaining wall in rear of tow-path side, lock 2, Oswego canal	1,105 00

UNSETTLED CONTRACTS.

TABLE No. 2.

Pending extraordinary repair contracts made since January 1, 1868. *Final not approved.*

EASTERN DIVISION.

Number.	Name.	Date.	WORK.	Act of Legislature.	Appropriation.	Engineer's estimate.	Engineer's estimate at contract prices.	Last estimate.	Percent'ge retained.	Last estimate, less per cent.	Payments by the auditor.
1006..	Denison, Henry D.	Sept. 9, 1869	Remov'g wall benches and constructing slope pavem't and wall from Pt. Schuyler to Lower Mohawk aqued't	877 of 1869	$433,993 13	$84,645 00	$74,183 40	$491,260 00	$73,689 00	$417,571 00	$417,571
1021..	Denison, Henry D.	Sept. 9, 1869	Remov'g wall-benches on Erie canal from junction of Chenango canal to east limit of Utica, and constructing wall near Clark street, eastward...	877 of 1869	47,000 00	18,497 00	10,617 00	50,700 00	7,605 00	43,095 00	43,095

WESTERN DIVISION.

1368..	E. W. Williams...	Oct. 22, 1874	Vertical wall at Clyde and Pit lock,	399 of 1874	$3,050 00	$3,050 00	$2,702 50	$1,100 00	$165 00	$935 00	$935 00

The securities under the contracts contained in Table No. 3 of the State Engineer and Surveyor's report on pending contracts, have all been returned, excepting the following:

Number.	Name.	Date.	WORK.	Act of Legislature.	Final account.	Security retained.
1305..	Thos. Gale...	Aug. 18, 1873..	Constructing vertical wall on berme side of Cayuga and Seneca canal, village of Montezuma..... ..	766 of 1873 399 of 1874	$846 48	$100 00
1302..	P. Corkings...	Aug. 19, 1873..	Removing wall-benches and constructing vertical wall on berme side of Erie canal, bet. Schuyler and Jason sts., Utica....	766 of 1873	15,215 40	1,500 00
1301..	P. Corkings...	Aug. 19, 1873..	Removing wall-benches and constructing vertical wall between James and Washington streets, Rome.....	766 of 1873	1,743 20	300 00

GENESEE RIVER FEEDER.

A law was passed at the last session of the Legislature (act chap. 369) providing for the abandonment of this feeder, if the State Engineer and Surveyor shall certify that it is no longer of use for canal purposes. In his opinion this feeder cannot safely be abandoned for the following reasons:

During continued east winds, the water in the Erie canal, in the vicinity of Rochester, often falls below the depth required for navigation. Several such instances have come under the personal observation of the State Engineer and Surveyor. In such cases water is freely drawn from the Genesee Valley canal in order to supply the deficiency. It could be drawn from this feeder were the dam kept in order.

In view of the early abandonment of the Genesee Valley canal, it is important that this feeder be retained; the dam should be maintained at its full height and the bulk-heads and gates kept in order. There would be no necessity for drawing water from the feeder, except on such occasions of low water in the Erie, and the milling interests would be as well protected as now; a waste-weir could readily be established so as to allow all the waste water to spill over into the mill-race, in the vicinity of the junction of the feeder with the Erie canal. Such a device would induce a gentle current through the feeder and keep it in a healthful condition.

SEWERAGE QUESTION OF BUFFALO.

The following extract, from a report made to the canal board April 13, 1876, expresses the views of the State Engineer and Surveyor on this subject:

"The natural outlet for the sewer system of Buffalo has been cut off by the building of the Erie canal along Black Rock harbor, and the State may, perhaps, be equitably bound to give aid to the city in providing a remedy.

"The proper outlet for the sewer system of Buffalo is, without doubt, directly into the Niagara river, which, by its great volume and swift current, can be made to carry all the sewerage entirely beyond the shores of the city. Both upon engineering and sanitary grounds, it is clear that this is the only satisfactory solution of this question. The city will very soon be forced to accept it.

"To carry this plan out, the outlet must be led *under* the canal. No serious engineering difficulties would be encountered, nor would the expense be very great.

"Without, however, discussing the merits of any special route or plan, the committee are decidedly of the opinion that the Bird avenue sewer should NOT be allowed to discharge into the canal. The canal having been separated from Black Rock harbor by the new division wall, is now a narrow stream having no outlet into the river; and its navigation, lately improved at great cost to the State, would be seriously obstructed by the discharge of solid matter from such a sewer, unless extensive and expensive dredging operations are carried on each season.

"The committee, therefore, respectfully recommend that the resolution offered on the seventeenth of February, to prohibit the city authorities from leading the Bird avenue sewer into the canal, be adopted."

The proper plan would seem to be to build outlets leading under the canal directly into the Niagara river at advantageous points, and a main belt sewer intercepting all the branches which do now, or are designed to, discharge into the canal, to connect with them. Such a plan would furnish Buffalo with an unrivaled sewer system.

MAIN AND HAMBURGH CANAL.

This canal is only a short inlet or basin, branching from the Erie canal, at Buffalo.

It has never been of use to the State, and is now a public nuisance. It was begun by the city of Buffalo, and before completion, it was,

by the peculiar canal legislation of former times, transferred as a burden to the State. It is one of the innumerable burdens which the Erie canal has had to support. It has cost the State large sums for its repair and maintenance. It is recommended that it be disposed of. The proper thing to do would be to fill it up, and provide otherwise for the sewerage.

Oak Orchard Creek Feeder.

This feeder passes through very low lands, and the effect of its banks is to cut off the natural drainage of all the lands lying to the eastward of it, while greatly improving the lands to the westward.

All the drainage of the lands to the eastward is sought to be led by private ditches into the feeder, but its water level is too high to make it an effectual outlet. The lands lying to the westward are generally in good arable condition, while those lying to the eastward are still swampy. Serious legal complications are involved in the questions relating to damages and remedies in this case.

Even if the feeder should be abandoned, which the State Engineer and Surveyor does not deem advisable, for reasons similar to those given in the case of the Genesee Valley feeder, and the drainage restored to the natural channels, great damage would result to the improved lands to the westward, although the lands to the eastward would certainly be improved. If the feeder is not abandoned it is evident that the owners of lands lying to the eastward must seek some other system of drainage than the natural or original channels, and must depend for compensation upon the success of their claims for damages from the State.

The damages resulting to these lands do not result from any defects in the banks or structures of the feeders, or from its general condition, but from the original plan adopted, which was called for by the surrounding circumstances.

What the legal rights of the owners are, under these circumstances, can only be determined by careful inquiries into the condition of the original transfers of land from the owners to the State, former awards and stipulated conditions, and the general laws relating to the subject. It can thus be determined whether the State, while maintaining the feeder, is under any obligations to aid the owners in developing an adequate system of drainage. There are, evidently, other systems of drainage available than the channels of the feeder or creek, although they are costly.

SPECIAL REPAIRS AND RECOMMENDATIONS.

During the past season the State Engineer and Surveyor has made frequent and extensive inspections of the canals, and examinations of nearly all of the structures and places which are stated in the reports of the division engineers to require repairs. He approves of their recommendations, with the following exceptions:

Middle Division.

Pratt Street bridge	$5,000 00
Upper Road bridge at Durhamville	2,000 00
Oswego dams	20,000 00

These items require further examination. There is no doubt of the importance of continuing the repairs to the aprons of the Oswego dams, but they should be executed as ordinary repairs. These dams are expensive and important stone structures and should be made entirely safe from the undermining action of the water. The worst places have already been protected by new aprons.

Western Division.

New side-cut lock at Tonawanda, estimated cost $60,000. The necessities at this point are not so pressing as to warrant such an expenditure, under the present financial conditions of the canals.

Three new stop-gates between Lockport and Rochester, estimated cost $18,000. These works should be executed as soon as funds are available. It is doubtful whether they can be carried out during the coming season.

The following subjects require special mention:

Chenango Reservoirs.

* "These reservoirs are essential to good navigation on the Erie canal, and must be retained. They are as follows: Madison Brook reservoir, Bradley Brook reservoir, Eton reservoir, Kingsley Brook reservoir, Hatch's Lake reservoir, and Leland's Pond reservoir.

"Considerable repairs are necessary to put them in good condition. The inner slopes of the banks of Madison Brook reservoir require brush and stone protection; and though these repairs are not of pressing importance, the banks should be carefully watched, from time to time, to provide against any dangerous encroachment.

"A new waste-weir and race-way is required at Hatch's Lake reservoir. They are now wooden structures, and can be repaired of the same material.

* From last report.

"There is no waste-weir at Eaton reservoir, and the depth of water is regulated by metal sluice-gates discharging through three iron pipes; one of the pipes is reported to be obstructed. It is not deemed safe that the regulation of so large and deep a body of water should depend solely on the present sluice-gates. It is highly important that this reservoir should be provided with an ample stone waste-weir and race.

The estimated cost of these, including minor repairs, is $20,000."

Provision was made to rebuild the Oneida, Limestone and Skaneateles Creeks dams, by the Canal Board, on September 5, 1876, by an appropriation of $7,400. The materials for Oneida Creek dam and Skaneateless Creek dam have been delivered, amounting to $1,571.95, but no work has been done. They should be completed at the low stage of water during the coming winter.

The division wall at Black Rock harbor, estimated cost $35,000. This work should be completed as soon as funds can be obtained. For further information on this subject, attention is invited to the division engineer's report and the last report of the State Engineer and Surveyor.

The supporting walls of the race-way, at the combined locks at Lockport, should be repaired at once; the estimated cost is $1,800.

The total amount for special and ordinary repairs, recommended in the reports of the division engineers, is $212,222. The estimates for these various works may, however, be somewhat modified upon further examination. The aggregate amount of the items objected to is $105,000, leaving for items approved $107,222. These repairs should all be provided for out of the ordinary repair funds, as rapidly as is possible. It may be necessary to postpone some of them. A large portion of them are, however, of the usual character of the annual ordinary repairs, and do not require special appropriations.

Great difficulties are experienced during the early part of the season at various points on the canals from the rapid growth of eel-grass. Careful measurements taking during July show that the water requires an additional head of one-quarter of an inch per mile in order to overcome the obstructions due to this grass. Many devices have been tried for removing it; the most successful of these seems to be heavy chains dragged astern of an ordinary tugboat. This subject still presents a field for invention.

Proper gauge marks should be made at frequent intervals on the structures of the canals, at standard heights, to furnish proper guides by

which to regulate the water supply. This has already been done on the western division by the division engineer. The data required for establishing these marks are embodied in the results of the Erie survey. This and the regulation of the heights of the waste-weirs are subjects of the greatest importance, for only by such methods can the enormous waste of water which now takes place be prevented. The division engineer of the western division has treated this subject in a very thorough manner, and his remarks deserve the careful attention of the Canal Commissioners and superintendents.

A general inspection of all the bridges on the constitutional canals was begun during the past season in order to obtain complete records of each bridge, giving its type, all its dimensions, its condition and all important facts connected with it. This inspection has been completed on the eastern and western divisions. The bridges are to be numbered consecutively from the ends of the canals nearest Albany. It is recommended that it be completed at an early period.

The general condition of the masonry of the various important structures of the canals requires the careful attention of those having charge of repairs. The personal inspection of the State Engineer and Surveyor discloses the fact, that there is scarcely an instance where the pointing of lock masonry remains sufficiently intact to afford proper protection to it from the weather. This is true of many similar structures.

In many works completed within four or five years the pointing has already become worthless. Such defects in new work result from carelessness or ignorance on the part of the superintending officials and the masons. In old work they are to be expected, as the usual effects of exposure to weather and age.

Good *pointing* requires a strict adherance to careful specifications.*

* The following precautions should be observed in laying and pointing masonry:

Laying of Masonry.—All stone should be thoroughly brushed clean and wet before being set, laid in a full bed of mortar, and when the rise of the stones is so great as to require it, the vertical joints grouted. All exposed joints should be scraped out clean to a depth of at least two inches, and made ready for pointing before the mortar has set hard.

Pointing.—The joints should be thoroughly brushed and wet immediately before pointing. The mortar for pointing should be composed of one part of cement and one part of clean, sharp sand, or a composition of equal strength, first thoroughly mixed dry, and afterwards wet with a quantity of water just sufficient to dampen the mixture, and thoroughly tamped into the joints, and the surfaces of the joints finally polished. In no case should the mortar *be allowed to project beyond the lips of the joints, but should follow all the irregularities of the faces of the stones,* in order to accomplish this result. This last precaution is especially applicable to rubble masonry.

It is of the greatest importance that the masonry of all the important structures should be kept well pointed, in order that the damaging effects of wet and frost may be avoided and their durability insured. The first cost of making these repairs will be considerable, but it is a necessary outlay.

Great defects have been observed in the concrete used for repairing bottoms of locks, foundations, etc. It has been the custom to pack the stone in the trench, and then to pour in thin grout, in order to make concrete. In many cases it has been discovered that, after four or five years, no appearance of concrete remains. In fact, the concrete is generally covered up before any test of its quality can be made, owing to the shortness of the time available for making the repairs. It is not to be denied that *grouting* is important under certain circumstances. The concrete should, however, be properly mixed before being placed, whenever this is possible, and then thoroughly rammed; if any scarcity of mortar is then observed, grout should be poured in. The proportions to be used, and mode of mixing, should be governed by the well-established theoretical and practical principles relating to this subject, and the materials in all cases measured.

Standard tests should be established for all cement used. As far as the engineers have had control of the purchase of cement, during the past two years, such tests have been made as were possible. The cement has necessarily been purchased in small quantities and at irregular intervals, thus preventing any extended tests. It is recommended that each division engineer's office be furnished with a testing machine, and that from time to time tests of the brands of cement in market be made, and a record kept of them for the guidance of officials making purchases. When the cement is purchased in small quantities and at irregular intervals, it is not possible to make critical tests, and the reputation of the brand is the principal guide. By keeping such a record of the principal brands the best may be selected.

The State Engineer and Surveyor has made every effort during his term to have these requisites of good construction observed, being convinced that great waste of money has resulted from carelessness in these small but very important matters.

The reports of the division engineers, hereto annexed, contain a large amount of important information, which cannot be set forth within the scope of this report, and deserve careful consideration.

GENERAL REMARKS.

A careful study of the financial condition and trade of the canals must convince those intrusted with their management, that the strictest economy must now be practiced, in all expenditures, if they are to be maintained in their present useful condition. It is, of course, folly to expect that the constitutional requirements relating to the canal debt can be observed. The problem, for some time, has been to secure sufficient revenue to pay their running expenses only; to so fix the tolls as to secure a large tonnage and a maximum revenue. The revenue, even now, is sufficient to cover the running expenses of the canals, if it is devoted only to the legitimate purpose of canal management.

Had the sums which have, in past years, been wasted on unnecessary works or stolen, been applied to the legitimate expenses of the canals, the debt would have long ago been paid; their banks and structures all placed in a permanent condition; and the possibility of even lower tolls than now established. It appears from the auditor's tables, that the canals have cost the people over and above their revenues, $34,653,199.95.* The actual cost of construction, to September 30, 1874, has been $76,076,906.74. It is evident, therefore, that a large part of this outlay has been repaid from the revenues.

Considering the rich development of the country along the lines of the main canals, and the advantages secured to the terminal cities, it cannot for a moment be doubted that this expenditure, notwithstanding all the waste of funds, has been a largely profitable investment to the people of the State.

The improved economy established in the management of the canals is shown by the following comparison of expenditures for the past five years:

* Amount of taxes levied to Sept. 30, 1876.

TOTAL EXPENDITURES for maintenance of the canals, including extraordinary repairs, awards for damages and miscellaneous payments, excluding only payments on debt and interest on same.

	1873.	1874.	1875.	1876.	1877.
Canal Commissioners	$2,353,974 90	$2,416,850 62	$1,538,253 87	$701,116 67	* $214,452 64
Contractors	61,017 29	14,162 46	243 00	....	....
Superintendents	1,047,812 00	1,161,859 00	† 984,862 10	† 830,677 02	† 929,311 84
Collectors and inspectors	83,824 85	84,833 44	75,857 41	73,371 15	55,565 43
Weighmasters	11,950 20	12,846 39	12,118 09	10,883 22	9,827 69
Miscellaneous	144,516 80	161,824 58	99,759 63	‡ 123,489 36	‡ 109,854 54
	$3,703,096 04	$3,852,376 49	$2,711,094 10	$1,739,537 42	$1,319,011 64

The above figures are taken from the auditor's financial report.
* Including awards for damages and amounts paid in settlement of old contracts.
† Includes expenditures by superintendents for extraordinary and special repairs, provided for by special funds.
‡ Includes engineering.

To these substantial results must be added the saving accomplished by act chapter 425, Laws of 1876. By that statute the numerous balances of funds appropriated by various acts, exclusive of funds for completion of Oneida Lake canal and Champlain enlargement, were collected into one fund of $1,638,358.22, and devoted to the real needs of the canals and the sinking fund. The appropriations under this act are as follows:

$400,000 00	to the fund for the settlement of contracts.
135,000 00	for such special repairs as the Canal Board may direct.
6,000 00	for sewers at Utica, under the Erie canal.
3,000 00	reappropriated for wall at Rome.
12,000 00	for iron bridge at Rome.
400,000 00	for improving water-way of the Erie canal.
15,000 00	for survey of the Erie canal.
630,325 66	Canal Debt Sinking Fund.
93,032 56	for interest, Sinking Fund.

The item of $400,000, for improving the navigation of the Erie canal, has not yet been used for that purpose. The greater portion of this fund was temporarily appropriated by the last Legislature to form a fund with which to open the canals, thus proving a most timely reserve. As the revenues have been just about sufficient to cover the running expenses of the canals, this fund is still nearly intact, what was temporarily used of it having been replaced from tolls received.

The last two items, amounting to $723,358.22, for the sinking fund, saved the people just that amount of taxation.

The total saving under this act amounts to at least $1,258,358.22, to which is still to be added whatever of the sum appropriated to the settlement of contractors' claims it may not be found necessary to use.

HUDSON RIVER IMPROVEMENT.

At the close of the season of navigation of 1876, there remained of the appropriation of $40,000, by act chapter 204, Laws of 1876, an unexpended balance of..... $13,080 06

Add appropriation, act chapter 412, Laws of 1877.... 15,000 00

Total available during season of 1877..... $28,080 06

The total expenditures during the past season have been, 27,171 59

Unexpended balance..... $908 47

The details of expenditure and of work done are shown in the following statement:

EXPENDITURES by the State Engineer and Surveyor under act chapter 204, *Laws of* 1876, *and act chapter* 412, *Laws of* 1877, *up to November* 1, 1877, *were as follows:*

BETWEEN TROY AND ALBANY.

Quantities.	LOCATION.	Price.	Amount.
4,532 cubic yards....	Fish-house	12 cents.	$543 84
6,157 cubic yards....	Round Shoals	12 cents.	738 84
14,144 cubic yards....	Covell's bar	12 cents.	1,697 28
24,833 cubic yards....	Total		$2,979 96
Two and five-tenth days dredge and tug at Fish-house, 611 cubic yards, $55 .		$137 50	
Six days dredge and tug at Troy, 1,738 cubic yards, $55		330 00	
Use of tug removing pile at Covell's bar		2 00	
			469 50
Total for dredging and extra work			$3,449 46
Inspectors, including their disbursements for transportation			262 40
Total expenditure above Albany			$3,711 86

BELOW ALBANY.

Quantities.	LOCATION.	Price.	Amount.
73,670 cubic yards...	New Baltimore	10 cts..	$7,367 00
68,889 cubic yards...	Mull's	10¾ cts..	7,405 56
4,974 cubic yards...	Stone Light	10¾ cts..	534 70
1,679 cubic yards...	Bogart's	10¾ cts..	180 49
49,952 cubic yards...	Overslaugh	10¾ cts..	5,369 84
2,845 cubic yards..	Cuyler's	10¾ cts..	305 84
202,009 cubic yards...	Total		$21,163 43
One and one-fourth days dredge and tug at Stone Light, $60		$75 00	
Five and one-tenth days dredge and tug at Overslaugh, 1,088 cubic yards, $55,		280 50	
Four and three-tenth days dredge and tug at Greenbush, 331 cubic yards, $50,		215 00	
Removing stump at Overslaugh		50 00	
			620 50
Total for dredging and extra work			$21,783 93
Inspectors, including their disbursements, etc			1,675 80
Total expenditure below Albany			$23,459 73

RECAPITULATION.

Total expenditures above Albany	$3,711 86
Total expenditures below Albany	23,459 73
Grand total	$27,171 59

Balance of appropriation unexpended (chap. 204, Laws of 1876), as per last report	$13,080 06
Add appropriation (chap. 412, Laws of 1877)	15,000 00
Total	$28,080 06
Deduct expenditure in 1877, as above	27,171 59
Unexpended balance November 1, 1877	$908 47

* No. of cubic yards removed in 1876, 136,709; cost..	$25,203 56
† No. of cubic yards removed in 1877, 226,842; cost..	26,081 59

Engineering included in above cost, 1876, $1,155.50, is 4.59 per cent of cost.

Engineering included in above cost, 1877, $1,938.20, is 7.43 per cent of cost.

Average cost per cubic yard, including engineering, in 1876	18.43 cents.
Average cost per cubic yard, including engineering, in 1877	11.49 cents.
Average cost per cubic yard of engineering, in 1876..	0.85 cents.
Average cost per cubic yard of engineering, in 1877..	0.85 cents.

Upon the opening of navigation last spring, surveys were commenced by Lieut. Willard (U. S. Engineers), for the purpose of ascertaining the location, extent and relative importance of the then existing obstructions. These having been determined, work was begun late in May, under an agreement with E. R. Seward, for dredging 70,000 cubic yards at New Baltimore, at ten cents.

Work was also commenced about the first of June at Mull's, under an agreement with Messrs. Brainard, Payn and Fenner, for dredging about 30,000 cubic yards at ten and three quarter cents.

Later, and in June, an agreement was entered into with the last-named contractors for dredging about 60,000 cubic yards at Overslaugh, including the removal of the old State dam, at ten and three-quarter cents per cubic yard.

Later in the season, dredging to a small extent was done at Albany and Troy, at a fixed compensation per day, or for a stipulated sum in gross; all of which fully appears in the foregoing statement.

* Excluding extra work, $1,716.38.

† Excluding extra work, $1,090.00.

The new channel at New Baltimore, commenced last year, has been completed and is in successful use. Three bars have been removed at Mull's, and the obstruction caused by the old State dam at the Overslaugh done away with.

An obstruction, in the form of an old submerged launching way, has been removed from the east side of the river opposite the city of Albany. The narrow channel opposite the "Hole in the Dyke," at Bath, has been materially widened and improved. The channel has been deepened below the high dyke and at "Covell's Folly," between Albany and Troy, and below the Saratoga railroad bridge at Troy. The upper end of the new channel below the State dam, at Troy, has been widened and improved so as to give unobstructed access from the sloop lock. Upon the opening of navigation last spring, this channel was found to be in perfect condition, with the full depth of water made last year.

The State Engineer is not aware that any serious detention has occurred, on account of low water, during the past season. He believes that navigation has been exceptionally good, and that the means which have been placed at his disposal are proved to have been efficiently expended.

For the possible requirements of the season of 1878, there remains an unexpended balance of only $908.47.

As the channels across the several bars which have been removed would be materially improved by increasing their width, and in view of the possible formation of new obstructions during the winter and spring freshets, an additional appropriation of, say $20,000, is respectfully recommended.

The State Engineer and Surveyor is indebted to General Newton and Lieutenant Willard, of the U. S. Engineers, for their valuable co-operation in the execution of these improvements.

CANAL TRANSPORTATION.

For several years past those interested in canal transportation have anxiously studied the question of steam propulsion, in the hope that it could be successfully applied on the canals, and that its introduction would cause a revival of their waning trade. Many attempts have been made during the past seven or eight years to introduce it on the canals; the old mode, however, with animal power, still prevails. The revival of trade during the past season has added renewed interest to this subject, and in the general effort to secure the cheapest mode of transportation steam propulsion has been used

to a greater extent than ever before. Its use has, however, not been general; a small portion only of the tonnage has been moved by steam power. The modes employed were: single steamers, like the "Baxter" boats; ordinary tugs, with a train of from two to five boats in tow; and the "steamer and consort" plan, in which an ordinary boat is pushed ahead of the steamer.

The following estimates of the cost of transportation by the several modes which have been used with success have been carefully prepared from data obtained from those practically conversant with the subject, and from the personal investigations of the State Engineer and Surveyor:

Average speed on canal necessary to make a certain number of trips in a season of 210 *days.*

MODE OF TRANSPORTATION.	NUMBER OF TRIPS.									
	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.
Speeds for Steamer..... Miles per hour.....	1.139	1.419	1.74	2.12	2.55	3.08	3.71	4.51	5.47	6.76
" Horse-boat..... " "	1.222	1.554	1.95	2.43	.....	.....	.....	.....	.....	.....
" Steamer and one boat..... " "	1.250	1.597	2.02	2 54	3.19	4 06	5.23	6.90	.....	.....
" Steamer and two boats..... " "	1.32	1.71	2.19	2.82	3.66	4.83	6.59	.....	.....	.....
" Steamer and three boats.. " "	1.39	1.84	2.42	3.20	4.26	6.05	.....	.....	.....	.....
" Steamer and four boats..... " "	1.48	1.99	2.70	3.69	5.27	8.10	.....	.....	.....	.....
" Steamer and five boats.... " "	1.57	2.08	3.02	4.35	6.72	.....	.....	.....	.....	.....

In making the above computations, the detentions to be deducted from the time of a round trip, in order to obtain the running time, are estimated as follows:

	Steamers.*	Horse boat.†	STEAMER AND BOATS IN TOW.‡ No. of Boats.				
			1.	2.	3.	4.	5.
In port..... Detentions.....	6 days.	6 days.	6 days.	6 days.	6 days.	6 days.	6 days
On river..... "	3 days.	4 days.	4 days.	4 days.	4 days.	4 days.	4 days
Lockages (72 locks).. "	¾ day.	1½ day.	2 days.	3.15 days.	4.35 days.	5.55 days,	6.72 days
Totals	9¾ days.	11½ days.	12 days.	13.15 days.	14.35 days.	15.55 days.	16.72 days

* Seven minutes allowed for each lockage.

† Fifteen minutes allowed for each lockage.

‡ Seven minutes for steamer and twelve minutes for each boat allowed for each lockage.

CURRENTS, IN MILES PER HOUR.

From Buffalo to Lockport, 31 miles, mean current, about....	+.78
Lockport to Rochester, 62 miles, mean current, about..	+.37
Rochester to Montezuma, 60 miles, mean current, about,	+.24
Montezuma to Jordan, 14 miles, mean current, about ..	—.12
Jordan to Geddes, 17 miles, mean current, about.....	+.12
Geddes to Rome, 43 miles, mean current, about.....	—.30
Rome to West Troy, 118 miles, mean current, about...	+.30
Mean easterly current	=.24

HORSE-BOATS.

On the Erie canal a first-class grain boat carries a cargo of about 230 tons, and the boat itself weighs about 65 tons. It is towed by two horses at one time, working six hours on and six hours off; the number of horses for each boat being four. Seven trips is the usual number for a season of 210 days, the time consumed for a round trip from Buffalo to New York and back, being thirty days. The time consumed from Buffalo to West Troy with a loaded boat, is about ten days. Mr. D. M. Greene, Deputy State Engineer and Surveyor, by examining seventy-two clearances of consecutive boats in 1872, concluded that the average time was ten days and two hours, giving a mean speed of 1.42 miles per hour; allowing one and one-half days for lockages, the speed for running time will be 1.67 miles per hour. The table gives 1.55 miles per hour, a close agreement. The easterly current being about $\frac{24}{100}$ of a mile per hour, the actual speed through the water will be about $1\frac{1}{3}$ miles per hour going east, and about 2 miles per hour with partial cargo, or light boat, going west.

In 1862 the average tonnage of a boat was 167 tons, and the time occupied from Buffalo to Troy was eight and one-half days. (See Auditor's Report on Tolls, Trade and Tonnage.) It is questionable whether, considering all circumstances, the boats are not now above the most economical size.

Estimate of cost of transporting wheat from Buffalo to New York, on Erie canal, with Animal Power; season 210 *days; number of trips per year seven, or thirty days per trip:*

INVESTMENT.

Cost of boat to carry 230 tons of cargo.....	$4,000 00
Cost of horses, four at $125	500 00
Cost of harness, four sets at $15	60 00
Total investment	$4,560 00

ANNUAL EXPENSES.

Interest on investment at 7 per cent		$319 20	
Maintenance. Reserve fund to replace boat in 10 years		289 60	
Maintenance. Repairs to boat, 8 per cent of cost		320 00	
Insurance on boat		20 00	
			$948 80
Crew, including board:			
One captain	$90		
One steersman	20		
Two drivers at $12	24		
One cook	10		
	$144 ×7 trips.		1,008 00
Keep of horses including shoeing { 4×$25 ×7 mos. / 4× 10 ×5 }		$900 00	
Reserve fund to replace horses in 6 years		69 90	
			969 90
River and harbor towage, $60×7 trips			420 00
Commissions, $25×7 trips			175 00
Insurance on cargo, $35×7 trips			245 00
Wharfage and incidentals, $7×7 trips			49 00
Total			$3,815 70

Tons transported eastward, 230×7	1,610.0	
Tons transported westward, 57.5×7	402.5	
		2,012.5

Cost per ton moved from Buffalo to New York, 495 miles	$1.896
Cost per ton per mile from Buffalo to New York	3.83 mills.
Cost of bushel of wheat moved 495 miles from Buffalo to New York	5.688 cts.
Tolls per bushel, Buffalo to Troy	1. 04 cts.
Elevating charges in New York	50 cts.
Trimming cargo	15 cts.
Total cost per bushel moved 495 miles and transshipped at New York	7.378 cts.

Cost per ton moved 495 miles, including one mill toll per mile for 345 miles (Buffalo to Troy)	$2 24
Cost per ton per mile, including above tolls=	4.53 mills.

DESCRIPTION OF THE STEAMER "WILLIAM BAXTER."

"The 'Baxter' was designed and built expressly to compete for the reward offered by the State, and is, therefore, a purely experimental boat, entirely unlike the ordinary Erie canal boat. She was built during the spring and summer of 1872, at Fishkill-on-the-Hudson, by Samuel Sneden, Esq., an experienced ship-builder of New York, from a model designed by William Baxter, Esq., of Newark, N. J., whose name she bears.

"Her dimensions and weight are as follows: Length, 96 feet 2 inches; breadth, 17 feet; depth of hold, 9 feet; weight, including machinery and water in the boiler, 57.2 tons.

"In model, the 'Baxter' resembles the 'log-bilge' boats of the New Jersey and Pennsylvania canals, being, however, somewhat sharper than those boats. Her bottom is perfectly flat, and her sides, stem and stern are vertical; so that she has a uniform horizontal section from her bottom up to 5½ feet draft. Above this, the sides are carried out, forming an overhang at the stern, for the protection of the screw and to give deck room.

"The form and dimensions of the immersed portion of the Baxter's hull are the same at bow and stern; so that, if a line be drawn athwart the plan, at right angles to the keel, and midway between the stem and the stern-post, such line would divide the plan into two equal and symmetrical parts. The sides converge from points distant 20 feet from both stem and stern, on curves of 30 feet radii. The area of the Baxter's bottom is 1,408.078 square feet. Her displacement, when drawing 6 feet of water, is therefore 8,048.468 cubic feet, or 264.015 tons, and her carrying capacity 206.815 tons. With a cargo of 200 tons, she should draw 5 feet 10 inches of water.* These results are deduced from the dimensions of the Baxter's plans. It is, however, stated that, as a matter of fact, when carrying 201 tons she draws only 5 feet 8½ inches of water.

"The machinery, which was built by the Fishkill Landing Machine Company, consist of a Baxter upright cylindrical boiler and a pair of Baxter compound condensing engines; these, together with the coal-bunker, engineers' berths and water-closet, occupy a space of 14 feet in length, at the stern.

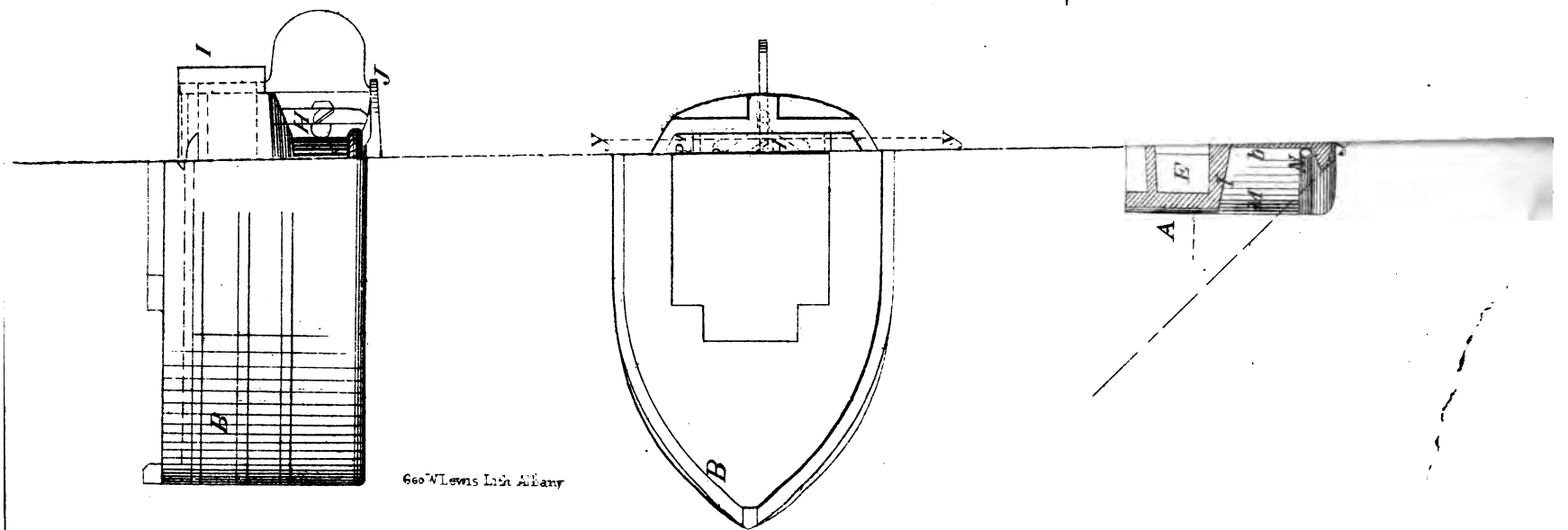
"The boiler is about 7 feet high, and has an external diameter of 46½ inches; the fire-grate is 27 inches in diameter, and the combustion chamber about 2 feet high; from the upper portion of the latter,

* Six inches immersion of the overhanging stern is not included.

W. BAXTER & W. BAXTER Jr.

Steam Canal Boats.

Patented Sept 15, 1874.



Geo. W. Lewis Lith. Albany

which is somewhat larger than the fire-grate, the products of combustion descend through 34 two-inch tubes 18½ inches long, after which they enter and ascend through an annular space about 3½ inches wide, to the smoke-pipe, whence they escape into the air. Outside of the annular space just referred to is a second annular space seven-eighths of an inch wide, through which the steam passes and is reheated on its way from the high to the low pressure cylinder.

"The boiler was originally covered with felt, and thoroughly lagged with wood, but as the latter was found to be liable to take fire from the excessive heat to which it was exposed, it was removed, and the 'salamander' felt substituted in its place. By this means, the loss of heat by radiation from the boiler, from which all the other boilers have suffered more or less, was effectually prevented. Altogether, the Baxter's boiler is remarkably economical for a power suited to its capacity. But it is too small for the duty required of it, and it has been found necessary to keep the small blower (a part of the original design) constantly running, in order to make the necessary amount of steam. The speed at which this blower — which was driven by a belt from one of the screw shafts — had to be run, in order to produce the desired result, was such that, especially at night, a stream of flame was seen frequently issuing from the top of the smoke pipe. In consequence of this loss of heat, the efficiency of the boiler was, of course, seriously impaired. The areas of the grate and heating surfaces are 4, and 160 square feet, respectively.

"The cylinders, which are vertical, are attached to either side of the boiler, and are jacketed; the jackets being connected to the boiler by pipes at top and bottom, so as to insure a constant supply of live steam to the outside, as well as to the inside of the cylinders. The high and low pressure cylinders are 7 and 12 inches in diameter, respectively, and the stroke of the piston is 12 inches; the admission of steam to both is suppressed at three-fourths the stroke, by lap upon the side valves, which are worked by the ordinary link motion.

"The condenser, which is exceedingly cheap and simple, as well as moderately efficient, consists simply of an extension of the exhaust from the low pressure cylinder through the side of the boat, where it connects with a three-inch iron pipe which passes around the stern and enters upon the opposite side, where a small air pump is located, and operated by a crank attached to the inboard end of the starboard shaft. The condensation is effected by the action of the water in the canal upon the exterior surface of the pipe outside the boat. The vacuum which is obtained by this means varies from 12 to 22

inches, depending upon the temperature of the water, quantity of steam used, etc. The water of condensation is, of course, returned directly to the boiler, and the necessity of supplying it from the muddy water of the canal entirely obviated. In the case of the 'Baxter,' the loss from leakage was a little more than replaced by a trifling leak in a joint of the condenser pipe, outside the boat, through which a very small quantity of water was forced inward by the excess of external pressure. This is an important feature of the Baxter plan, as by it the accumulation of mud in the boiler is almost, and may be wholly, prevented.

"The Baxter is propelled by two three-bladed true screws, 4½ feet in diameter and 4 feet pitch, placed on each side of the stern, and revolving toward each other at the bottom; uniform motion of the two being secured by a cross-shaft and miter wheels. The disc area of the two screws is 14.3 square feet, or 14 per cent of the immersed midship section when the boat is loaded.

"The reversing lever, throttle valve and steam whistle are all so arranged as to be within easy reach of the steersman, and the steam and vacuum gauges are so disposed as to be easily seen from the wheel, so that a single person may perform the duties of steersman and engineer at the same time; the fireman being thus free to give his whole attention and time to the fire, and to keeping the engines properly oiled.

"The Baxter was launched about the 10th of August, 1872; made a preliminary trial trip on the 24th, and on the 27th of the same month left Newburgh for Buffalo on her first competitive trial trip."*

Estimate of cost of transporting wheat from Buffalo to New York on Erie Canal, on "Baxter" steamers, costing $6,500 *each, and making* 10 *round trips in* 210 *days, carrying* 210 *tons east, and* 52.5 *tons west, or one-fourth eastward cargo.*

ANNUAL EXPENSES.

Interest on cost of boat at 7 per cent	$455 00	
Maintenance of boat and machinery, 15 per cent,	975 00	
Coal, 14 tons × 10 trips at $4 per ton.....	560 00	
Oil, tallow and waste, $12, × 10 trips	120 00	
Insurance on boat...	32 50	
		$2,142 50

*Report of 1872 of D. M. Greene, Esq., engineer to the commission appointed to investigate the subject of steam on the canals.

Brought forward		$2,142 50
Cost of crew:		
One captain 7 months at $50	$350 00	
Two engineers 7 months at $37.50	525 00	
Two deck-hands 7 months at $30	420 00	
One cook 7 months at $10	70 00	
Board, 6 persons 210 days at 50 cents	630 00	
		1,995 00
Insurance on cargo $35 × 10 trips		350 00
Commissions $25 × 10 trips		250 00
Wharfage and incidentals $30 × 10 trips		300 00
Total		$5,037 50
Tons transported 495 miles east 10 × 210=		2,100
Tons transported 495 miles west, 10 × 52.5=		525
		2,625
Cost per ton moved from Buffalo to New York, 495 miles		$1 92
Cost per ton per mile from Buffalo to New York=		3 $\frac{88}{100}$ mills
		Cents.
Cost per bushel of wheat moved 495 miles, from Buffalo to New York		5.76
Tolls per bushel, Buffalo to Troy		1.04
Elevating charges in New York		.50
Trimming cargo		.15
Total cost per bushel moved 495 miles and transhipped at New York		Cents. 7.45
Cost per ton moved 495 miles, including one mill toll per mile for 345 miles (Buffalo to Troy)		$2.265
Cost per ton per mile, including above toll		4 $\frac{58}{100}$ mills

CABLE TOWING.

The Belgian System.

"The system is simple, consisting of a wire cable laid on the bottom of the canal through its entire length, and fastened at the two extreme ends; and a steam tow-boat, provided with an additional engine, to which is attached a clip-drum or grooved driving wheel, with suitable guiding and tightening pulleys. Thus equipped, and

the boats to be towed made fast to the tow-boat, the process of towing is performed by lifting the cable from the bottom of the canal by means of a grapple, and placing it over the clip-drum. This drum is then put in motion (turned) by machinery in the tow-boat, causing the cable to pass over it without slipping, and fall back again into the canal at the stern of the tow-boat. Thus the tow-boat is drawn along the cable, and consequently through the canal, with the same facility that a locomotive is drawn on the rails, with this difference: the rail is stationary and the locomotive *wheel passes over it*, while the *cable* is flexible and *passes over the drum.*" The accompanying drawing fully explains the system, and the Fowler clip-drum or pulley.

In order to make a fair comparison between the cost of canal transportation by the several systems, it will be necessary to provide in the case of the Belgian system, for the equipment of the entire canal and for putting it in condition to do all the towing which the business of the canals requires.

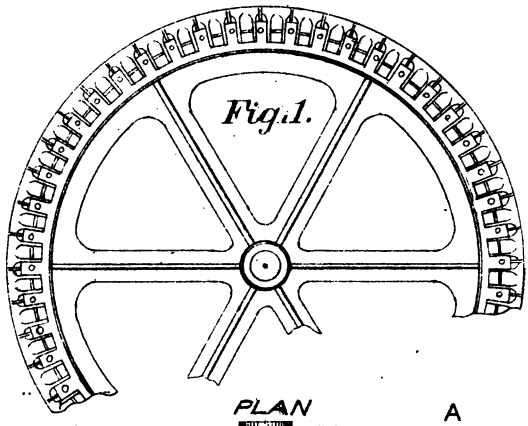
As a basis of estimate we shall assume an eastward movement of 3,000,000 tons, annually, and a westward movement one-forth as great, or 750,000 tons; making an average annual tonnage movement of 3,750,000 tons. The season of navigation being taken at 210 days, the average daily shipments east from Buffalo, would appear to be $\frac{3,000,000}{210} = 14,286$ tons. The average cargo being taken at 230 tons, 62 boats would seem to be required to leave Buffalo daily during the season. As a matter of fact, however, a very considerable amount of freight moving east, reaches the canal east of Buffalo; but, as business cannot be uniformly distributed, and as a maximum demand must be provided for, we shall take the number of boats starting east from Buffalo, at 60, in our estimate.

Estimate of the cost of transporting wheat from Buffalo to New York, 495 miles, by the Belgian or wire cable system; assuming that 3,750,000 tons are transported per annum.

1st. Estimate for 8 round trips per annum. Speed between locks 2.42 miles per hour (see preceding table); or through the water running eastward, $2.42 - .24 = 2.18$ miles per hour. Train composed of 3 boats, each carrying 230 tons east and one-fourth cargo west. The traction for a single grain boat, towed at the rate of 2.45 miles per hour through the water, was found by experiment to be about 524 pounds. At a speed of 2.18 miles per hour through the water, the traction would be about 415 pounds. The resistance per train would be, therefore, $3 \times 415 = 1,245$ pounds. Add 255 pounds

Fowler Clip Pulley.

ELEVATION



PLAN

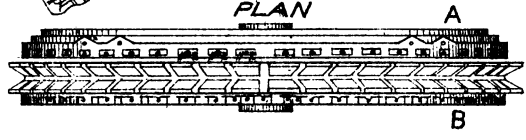


Fig.2.

SECTION. A.B.

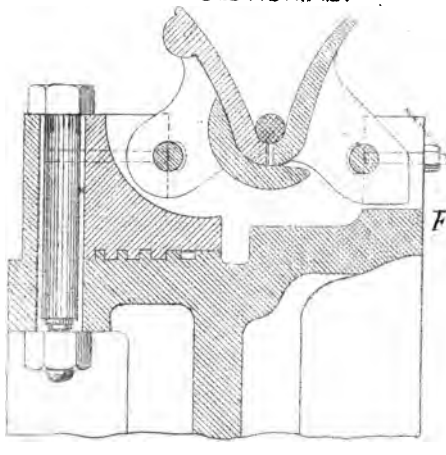
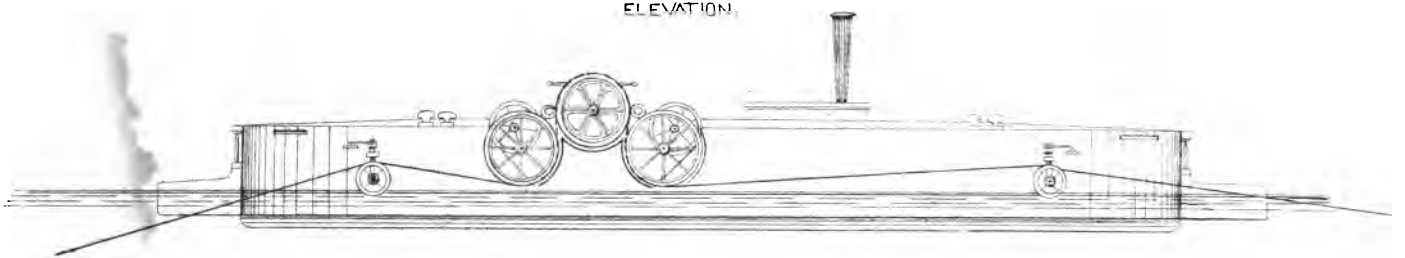


Fig.3.

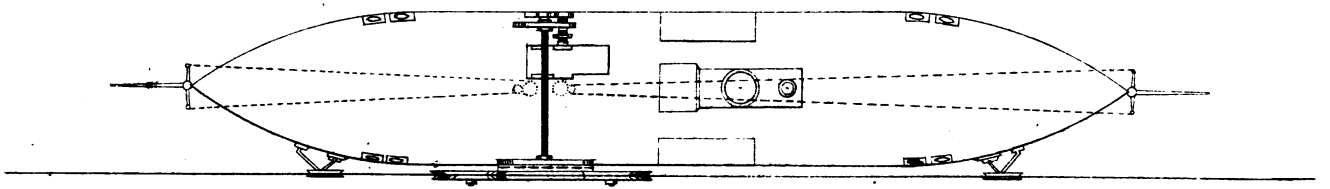
Geo W Lewis Lith. Albany

Cable Tow-boat with Vertical Pulley, and moveable Guide Pulleys 15 Horse Power.

ELEVATION.



PLAN



J. Fowler & Co, Scale 1 to 200.

Geo. W. Lewis Lith. Albany

for the tow-boat and there results about 1,500 pounds as the total strain on the cable due to one tug with train. The effective horse-power required would be about 9.68 H P; and the indicated horse-power required will not be far from $9.68 \times \frac{3}{2} = 15$ H P.

The coal consumption would be about 6 pounds $\times$ 15 H P = 90 pounds per hour, or about 1 ton per day. Considering the variable and various strains to which the cable would be subject from several trains more or less concentrated, and the wear and tear, the diameter should not be less than $1\frac{1}{8}$ inch, which will be sufficient to provide for such variations of speed as are likely to occur. The cost of such a cable would be 25 cents per foot, or $1,350 per mile for wrought iron, which is considered better for the purpose than steel.

At a speed of 2.42 miles per hour, assuming that there will be no delay from waiting for tows at the locks, the time required to make a trip from Buffalo to Troy will be $\frac{345}{2.42} = 142.56$ hours $= 5.94$ days. The number of trains required would, therefore, be at least $20 \times 5.94 = 118.8$ trains, say 120 each way, or 240 trains altogether, and the same number of tugs.

Taking these estimates as a basis, the cost of equipment will be as follows:

EQUIPMENT — TUGS.

240 × $10,000		$2,400,000 00
Add contingencies		50,000 00
		$2,450,000 00
Cables, 690 miles, at $1,350	$931,500 00	
Fitting lock-gates	25,000 00	
Add laying cables and contingencies	43,500 00	
		1,000,000 00
Total equipment		$3,450,000 00

DAILY COST OF TUG.

One ton coal, $4	$4 00
One captain, $3	3 00
Two engineers, $2.50	5 00
One splicer, $2.50	2 50
Two men, $1.25	2 50
One cook, fifty cents	50
Board for seven at fifty cents	3 50
Oil and waste	2 00
	$23 00

Life of cable 6 years.

Sum to be annually invested to renew cables in 6 years at 7 per cent = $\frac{1,000,000}{7.18}$ = $139,846.

The annual cost of maintaining and operating tugs and cables, will therefore be:

Interest on equipment, 7 per cent	$241,500 00
Two hundred and forty tugs, 210 days, at $23	1,159,200 00
Maintenance of tugs, 10 per cent	240,000 00
Renewal of cable	139,846 00
Insurance of tugs, one-half per cent	12,000 00
	$1,792,546 00

Tons transported, 3,750,000. Cost per ton, Buffalo to New York ..... 47.80 cts.

ANNUAL EXPENSE OF EACH BOAT TOWED.

Cost of boat		$4,000 00
Interest, 7 per cent		$280 00
Reserve fund to replace boat, in 10 years		289 60
Repairs, 8 per cent		320 00
Insurance on boat		20 00
		$909 60

Crew, including board:

One captain	$90	
One steersman	20	
One deck hand	20	
One cook	10	
	$140 × 7 trips=	980 00
River and harbor towage, $60 × 8 trips		480 00
Commissions, $25 × 8 trips		200 00
Insurance on cargo, $35 × 8 trips		280 00
Wharfage and incidentals, $7 × 8 trips		56 00
Annual cost for one boat		$2,905 60
Tons transported in one boat eastward, 230 × 8		1,840 00
Tons transported in one boat westward, 57.5 × 8		460 00
Total tons per annum		2,300 00

Cost per ton, $\frac{2005.60}{5800}$ =	$1.263
Add cable towage =	.478
Cost per ton, Buffalo to New York, 495 miles	$1.741
Cost per ton per mile	$3\frac{52}{100}$ mills.
Cost per bushel of wheat, 495 miles	5.22 cts.
Tolls per bushel, Buffalo to Troy	1.04 cts.
Elevating charges in New York	.50 cts.
Trimming cargo	.15 cts.
Total cost per bushel moved 495 miles and transshipped at New York	6.91 cts.
Cost per ton moved 495 miles, including 1 mill toll per mile for 345 miles (Buffalo to Troy)	$2.08½
Cost per ton per mile, including above toll	$4\frac{21}{100}$ mills

2nd. Nine round trips per annum; speed, 3.2 miles per hour = 2.96 miles per hour through the water (east). Traction = $524 \times \frac{2.96^2}{3.18^2}$ = 763 pounds for a single boat. Traction per train of 3 boats = 763×3 = 2,289 pounds.

Add for tug at above speed ..... 400 pounds.

Total traction = ... 2,689 pounds.

Effective horse-power required = $21\frac{1}{4}$ H P.

Indicated horse power about = 32 H P.

Coal required per hour — 32×6 = 192 pounds = $2\frac{1}{8}$ tons per day.

EQUIPMENT.

Time required for 1 trip from Buffalo to Troy = $\frac{345}{3.2}$ = 108 hours = $4\frac{1}{2}$ days.

Number of tugs required = $20 \times 4\frac{1}{2} \times 2$ = 180 (20 trains per day each way).

180 tugs at $10,000	$1,800,000 00
Contingencies	40,000 00
Cable as before	1,000,000 00
Total for equipment	$2,840,000 00

The daily cost for tug would be increased by 1.3 tons of coal at $4 = $5.20, and would, for this case, be $28.20.

The annual cost of maintaining and operating cables and tugs will be:

Interest on equipment at 7 per cent	$198,800 00
180 tugs at $28.20 per day, 210 days	1,065,960 00
Maintenance of tugs, 10 per cent	180,000 00
Renewal of cables	139,846 00
Insurance of tugs, one-half per cent	9,000 00
Total yearly cost	$1,593,606 00

Tons moved, 3,750,000.

Cost of towing, per ton, from Buffalo to Troy, = $0.425.

Annual expense for each boat towed:

Maintenance of boat, as before	$909 60
Crew, including board, $140 × 7	980 00
River and harbor towage, $60 × 9	540 00
Commissions, $25 × 9	225 00
Insurance on cargo, $35 × 9	315 00
Wharfage and incidentals, $7 × 9	63 00
	$3,032 60

Tons transported: Eastward, 230 × 9 = 2,070

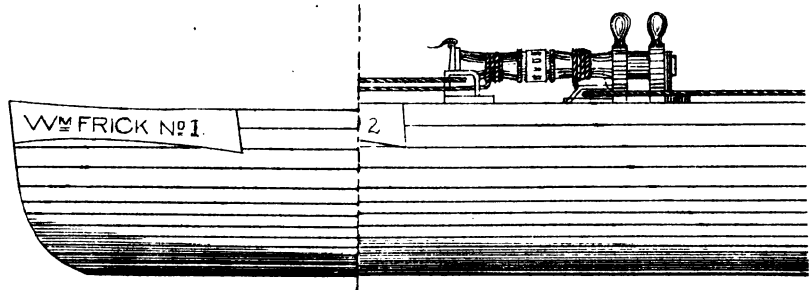
Tons transported: Westward, 57.5 × 9 = 517.5

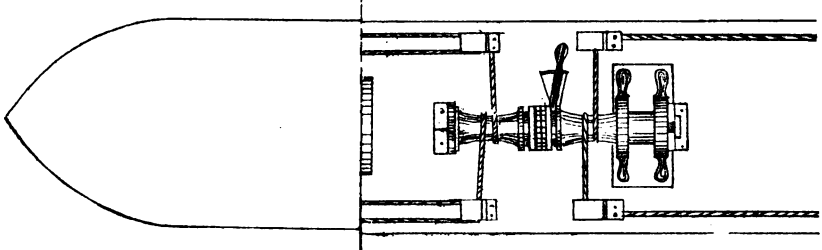
2,587.5

Cost per ton, $\frac{3032.60}{2587.5}$ =	$1.171
Add cable towing =	425
Cost per ton Buffalo to New York, 495 miles	$1.596
Cost per ton per mile	$3\frac{22}{100}$ mills.
Cost per bushel of wheat moved 495 miles	4.79 cents.
Tolls	1.04 cents.
Elevating	.50 cents.
Trimming	.15 cents.
	6.48 cents.
Cost per ton, 495 miles, including 1 mill toll	$1 94
Cost per ton per mile, including toll	$3\frac{22}{100}$ mills.

COUPLED BOATS.

A large economy results from coupling boats on the plan adopted on the Pennsylvania canals, whether steam or horse power is used





Heavy

The boats being fastened in pairs close together, one ahead of the other, the total resistance is much less than for two single or separated boats; and, besides, the number of the crew can be very much reduced below what is required for two such boats.

General Wistar, president of the Pennsylvania Canal Company, in treating of this subject in his report for 1874, says: "The freight in single boats exceeded that in double boats exactly 25 per cent, besides, which, a considerable profit included in interest charged upon capital invested in boats, was earned on the boat rents, which is included in the above estimate of cost. This cost would be further reduced by the exclusive use of double boats." It is evident that most of the advantages of an enlarged boat are secured by coupling two ordinary boats in this manner; both boats can be steered with one wheel, and can pass sharp curves with the same ease as single boats. The accompanying sketches, taken from the pamphlet of the patentee, Mr. William Frick, of Chester, Penn., fully explain this mode of coupling boats, and deserve the careful attention of those engaged in canal transportation.

Estimate of cost of Transporting Wheat from Buffalo to New York, in Coupled Boats moved by steam power.

1st. Nine round trips per annum; speed over ground, between locks, 2.54 miles per hour, or through the water 2.54—.24 = 2.30 miles per hour.

The single Baxter steamer, in 1873, made a speed of 3.26 miles per hour over the ground, with a coal consumption of 617 pounds, over a distance of 34 miles in 12 hours. This is at the rate of $\frac{617}{34} = 18.15$ pounds per mile, or 50 pounds per hour, or 1,200 pounds per day. In 1872 the mean annual rate was 31.04 pounds per mile (see report of engineer to commission on steam on the canals), and the mean speed was about three miles per hour over the ground; this gives about 93 pounds of coal per hour, or 2,232 pounds per day. The improvements added in 1873 very materially reduced the rate of consumption of coal, as is evident from the above comparison. The smaller rate, 18.15 per mile, is, however, considered exceptional, and due to extraordinary care in firing during the trial trip. The practical rate for this speed is from 25 to 31 pounds per mile.

From the above results, it will evidently be entirely safe and fair to take the rate of consumption of coal at one ton per day for the steamer alone. The resistance of the coupled steamer and boat will

not exceed two-thirds that of two similar single boats, and the coal consumption can therefore be taken at about 1½ tons per day. The running time will be $\frac{210}{9}$ $\frac{\text{days}}{\text{trips}}$ — 6 (days in port) = 17.33 days; coal, 1.5 × 17.33 = 26 tons per trip.

First cost:	
Steamer	$6,500 00
Consort	4,000 00
Total	$10,500 00
Annual expense:	
Interest on investment 7 per cent	$735 00
Maintenance, 15 per cent	1,575 00
Coal, 26 tons × 9 trips, *a* $4.00	936 00
Oil, tallow and waste, $12.00 × 9	108 00
Insurance on steamer, one-half per cent	32 50
Insurance on consort	20 00
	$3,406 50
Captain and crew of steamer, and board	1,995 00
Crew of consort, and board, $140.00 × 7	980 00
Insurance on cargoes, $35.00 × 2 × 9	630 00
Commissions, $25.00 × 2 × 9	450 00
Wharfage and incidentals, $30.00 × 9 + 7 × 9	333 00
Total annual cost	$7,794 50
Tons transported 495 miles:	
East, (210 + 230) × 9	3,960
West, (210 + 230) ¼ × 9	990
Total tons moved 495 miles	4,950
Cost per ton, 495 miles	$1.574
Cost per ton, per mile	3 $\frac{18}{100}$ mills.
Cost per bushel wheat, 495 miles	4.72 cts.
Tolls, Buffalo to Troy	1.04 cts.
Elevator charges in New York	.50 cts.
Trimming	.15 cts.
Total cost per bushel, moved 495 miles and transhipped at New York	6.41 cts.

Cost per ton, including tolls	$1.92
Cost per ton per mile, including tolls (Buffalo to Troy)	3.88 mills.

2d. Ten round trips; speed 3.20 miles over ground, 2.96 miles through water, per hour.

Coal per day $1.5 \times \frac{2}{3}.\frac{1}{3}\frac{4}{0}\frac{2}{2} = 2.5$ tons per day for 15 days = 37.5 tons for round trip.

Annual cost:

Interest and maintenance as before	$2,310 00
Coal, 375 tons, at $4	1,500 00
Oil, tallow and waste $12 × 10	120 00
Insurance on steamer	32 50
Insurance on consort	20 00
	$3,982 50
Crew of steamer and board	1,995 00
Crew of consort and board	980 00
Insurance on cargoes $35 × 2 × 10	700 00
Commissions $25 × 2 × 10	500 00
Wharfage and incidentals $30 × 10 + 7 × 10	370 00
Total annual cost	$8,527 50

Tons transported 495 miles:

East (210 + 230) × 10 =	4,400
West (210 + 230) × ½ × 10 =	1,100
Total tons moved 495 miles	5,500
Cost per ton moved 495 miles	$1.55
Cost per ton per mile	$3\frac{18}{100}$ mills.
	Cents
Cost per bushel wheat 495 miles	4.65
Tolls, Buffalo to Troy	1.04
Elevator charges, New York	.50
Trimming	.15
Total cost per bushel, moved 495 miles, and transhipped at New York	6.34
Cost per ton, including tolls	$1.89½
Cost per mile (B. to N. Y.)	3.83 cts.

TABLE showing the estimated costs of transportation of freight between Buffalo and New York, by various modes of movement (summary of preceding estimates):

Number.	MODE OF MOVEMENT.	No. of round trips.	ESTIMATED COST						Per cent.
			EXCLUSIVE OF TOLLS.			INCLUSIVE OF TOLLS.			
			Per ton.	Per ton mile.	Per b'sh. wheat.	Per ton.	Per ton mile.	Per b'sh. wheat	
				mills	cents.		mills.	cents.	
1	By animal power.....	7	$1.896	3.83	5.688	$2.24	4.53	7.378	99.
2	By Baxter steamers.....	10	1.92	3.88	5.76	2.265	4.58	7.45	100.
3	By Belgian system.....	8	1.741	3.52	5.22	2.085	4.21	6.91	92.7
4	By Belgian system.....	9	1.596	3.22	4.79	1.94	3.92	6.48	87.
5	By steamer and consort...	9	1.574	3.18	4.72	1.92	3.88	6.41	86.
6	By steamer and consort...	10	1.55	3.13	4.65	1.895	3.83	6.34	85.1

FREIGHTS PER BUSHEL FOR SEASON OF 1877.

Average.

	Wheat.	Corn.
Chicago to Buffalo.....	3.57 cts.	3.23 cts.
Buffalo to New York	7.39 cts.	6.38 cts.
Chicago to New York	10.96 cts.	9.61 cts.

FROM SEPTEMBER 1, TO CLOSE OF NAVIGATION.

	Wheat.	Corn.
Chicago to Buffalo.....	4.63 cts.	4.02 cts.
Buffalo to New York	9.53 cts.	8.08 cts.
Chicago to New York.....	14.16 cts.	12.10 cts.

In considering the results of the foregoing estimates, and in comparing them, successively, with estimated cost of movement by animal power, as at present employed, it will be observed that the Baxter steamer, making 10 round trips the season, accomplishes a given result at a slightly greater cost than the horse-boat; that, in the case of the Belgian system, towing trains of 3 boats, and the towed boats making either 8 or 9 round trips, the same result is obtained at a cost of from half a cent to a cent per bushel less than by either of the first two modes mentioned; and that, by the steamer and consort system, the boats making 9 or 10 round trips, the same result is accomplished, at a cost about 1⅛ cents per bushel cheaper than by the horse-boat or Baxter steamer singly.

In relation to the several modes of transportation considered, the following remarks seem appropriate:

1. *Animal power.*— Seven round trips the season, being rather more than the best average performance, the cost deduced may be regarded as the minimum limit.

2. *Baxter steamers.* — The above estimate, it is thought, fairly represents the cost of towing by single steamers of improved model. In estimating the tonnage moved, the same ratio of westward to eastward cargoes, one-fourth, is used for each mode, this is fixed by the ratio of the aggregate westward to the aggregate eastward tonnage. It is true that a few steamers may temporarily secure the advantages of a larger westward tonnage than corresponds with this ratio, but it is quite evident that no *general* system can, for even the railroads do not much exceed it.

It is evident that the "Baxter" or single steamers, can successfully compete with the horse-boats, only in case their increased speed on the canals, — making a difference of about 5 days per trip from Buffalo to New York,— should prove a sufficiently important advantage. As merely a cheap mode of transportation it is doublful whether they can compete with animal power.

3. *The Belgian system.* — In this case it has been assumed that the entire canal has been fully equipped with cables and tugs, and that the entire business of the canals is done by this system. It is clear that, for any other condition, the actual cost would be greater than our estimate. In other words, the results given may be regarded as the most favorable exhibit that we are warranted in making for this system. The difficulties and delays in passing locks are of a serious character, and it is not thought to be practicable to tow more than three boats in one train with economy. There are also difficulties connected with the cables, such as entanglements, kinks, and breakages, which must all be considered in estimating the practicability of this system. The system has, however, been tried with some success on rivers and canals in Europe; and it may be that this system, applied to some of the longer levels, only, and employed in conjunction with animal power on the short levels, might prove remunerative, and at the same time slightly reduce the cost of transportation.

In any event, however, whether it be proposed to employ this system upon the whole, or upon only a part of the canal, it is believed that its introduction should be left to private enterprise.

4. *The Steamer and Consort.* — This system is not only entirely practicable, but it is within the reach of boatmen or others of ordinary

means, and it certainly gives promise of ultimate success if judiciously managed. It admits of gradual adoption and a healthy growth. The consort may be the ordinary horse-boat at first, and until the boats of that class now in existence shall have gradually died out and been replaced by boats of more suitable model.

EXPERIMENTS WITH DYNAMOMETER.

During the latter portion of the season a series of experiments with the dynamometer were begun, in order to determine the tractive force required to move canal boats at different speeds. Owing to the lateness of the season it was not possible to carry them sufficiently far to establish a reliable formula expressing the relation between velocity and resistance. Some very important facts, however, were established. The following table of the results of the experiments is given, with the caution that the experiments were of a preliminary character and not sufficiently accurate in all cases to determine the mathematical laws involved.

The experiments were made with the ordinary boats, towed both by horse-power and steam tug. A remarkable difference appears between the resistances of the boats towed by horse-power and the boats towed by the steam tug. The resistance of the boats when towed by the steam tug (an ordinary screw propeller), is seen to be about 1.40 times that of the horse boats for a speed of 1.40 miles per hour; and 1.80 times that of the horse boats for a speed of about 2.50 miles per hour. The length of hawser or towing-line used was from 250 to 300 feet, or as long as is generally practicable on the canals. This increased resistance is due entirely to the rapid current thrown back by the propeller in the confined water-way of the canal. These experiments demonstrate the impracticability of economically towing on the canal with ordinary tug-boats. The experiments with two boats coupled together, one ahead of the other, were made with the tug-boat, and were sufficiently accurate to base a formula upon them, expressing the law of the resistance and speed under such conditions. They show a great reduction in the resistance of coupled boats below that of two single or separated boats. The difference is about 800 pounds for a speed of 2½ miles per hour; in other words, two single boats require a traction force of about 2,700 pounds, and two coupled boats only 1,900 pounds, at this rate of speed on the old canal. This difference is much less at lower rates of speed; at a speed of about 1.8 miles per hour, it is about 319 pounds, 1,489 pounds being required for two single boats, and 1,170 pounds for the coupled boats;

nade in November, 1877.

ISTANCE OR TIVE FORCE. ed,	Component parallel to motion of boat, lbs.	Resistance or tractive force per square foot, immersed section.	REMARKS.
	207.0	18.5	S. Walker — Length ..... 95 feet.
S.	304.2	2.90	Width ..... 14 "
S. 5	354.4	3.47	Light weight ..... 54,000 lbs.
A.	435.1	4.14	No cargo.
S. 6	504.8	4.74	
T.			
			S. Evans — Length ..... 95 feet.
			Width ..... 17½ "
8	.....	13.60	Draft ..... 6 "
R 8	.....	10.42	Light weight ..... 129,000 lbs.
S 0	.....	11.69	Weight cargo ..... 459,600 "
F 3	.....	11.70	Weight at weigh-lock ..... 588,000 "
F 4	.....	.....	
G 0	.....	.....	
G			
			A. H. Smith — Length ..... 95 feet
			Width ..... 17½ "
0	.....	3.99	Draft ..... 5.9 "
0	.....	4.14	Weight cargo ..... 434,310 lbs.
5	.....	4.55	Weight light ..... 119,000 "
6	.....	7.40	553,310 lbs.
0	.....	9.89	
0	.....	9.47	
7	.....	11.14	
0	.....	13.55	T. C. Davis — Length ..... 94 feet.
			Width ..... 17½ "
			Draft ..... 6.1 "
			Weight cargo ..... 459,200 lbs.
			Weight light ..... 116,600 "
7	.....	3.19	575,800 lbs.
7	.....	3.81	
7	.....	7.08	Freddie — Length ..... 94 feet.
2	.....	6.85	Width ..... 17½ "
2	.....	7.14	Draft ..... 6.3 "
6	.....	8.66	Weight cargo ..... 479,940 lbs.
2	.....	9.16	Weight light ..... 138,500 "
0	.....	9.77	Weight at weigh-lock ..... 606,000 "
0	.....	10.49	
0	.....	11.01	G. W. Perkins — Length ..... 95 feet.
3	.....	13.79	Width ..... 17½ "
2	.....	14.21	Draft ..... 6 "
0	.....	14.86	Weight cargo ..... 473,600 lbs.
			Weight light ..... 138,600 "
			612,200 lbs.
1	.....	.....	
7	.....	.....	R. W. Stroud — F. Brodock — Length .... 93 feet.
3	.....	.....	Length .... 95 feet. Width .... 17½ "
2	.....	.....	Width ..... 17½ " Draft ..... 5½ "
0	.....	.....	Draft ..... 9.9 " Weight cargo ..... 353,100 lbs.
0	.....	.....	Weight light ..... 120,000 "
0	.....	.....	473,100 lbs.
0	.....	.....	

at a speed of about two miles per hour, the difference is about 530 pounds, 2,948 pounds for two single boats, and 1,518 pounds for the coupled boats. It was not possible to make similar experiments within the available time with the horse boats thus coupled. It is to be remarked that, although the canal boats used in these experiments were nearly of the same tonnage and shape, the condition of the surfaces exposed to the friction of the water was necessarily variable, and the cross-section of the prism was also variable, which will account for some of the apparent discordances of the tables.

It appears from the table that the resistance of an ordinary grain boat with full cargo, weighing, *in gross*, 293 tons, and towed by horse-power, is 316 pounds for a speed through the water of 1.44 miles per hour = 126.8 feet per minute, taking the results of the trial with the "S. Evans." This speed through the water is about the average for eastward bound boats; these have the benefit of the general eastward current of the canal, which is about one-fourth of a mile per hour, making the average speed, over the ground between Buffalo and Troy, about $1\frac{1}{4}$ miles per hour, as before stated.

Work of Canal Horses.

It thus appears that the work thrown upon each canal horse is $\frac{3}{2}\frac{1}{6} \times 126.8 = 20{,}034$ pounds-feet per minute, or $\frac{6}{10}$ horse-power, or for a whole day of twelve hours (6 hours on and 6 hours off) 14,424.480 pounds-feet. By comparing this result with the following deductions of General Morin, and other high authorities, it will be seen that our canal horses, which are of small size, are overtaxed.

"Now, from the results of direct experiments upon the work developed by horses employed in other modes of transportation, some of which are inserted in the following table, we see that horses employed in hauling fast boats develop per second, during their service, a quantity of work more than triple as a mean of that of the carriage horse, and equal to one and a-half times that of the diligence horse, which occasions excessive fatigue, producing diseases of the lungs, of which they nearly all die. In exceptional cases, where the wave is in front, we have said that at a velocity of 13.84 feet, the resistance has sometimes equaled 617 pounds, which exacts from each horse an effort of 205.66 pounds, and the excessive work of 205.66 pounds × 13.84 feet = 2,846 pounds-feet in one second, during a time of more than one or two minutes, whence results straining of the hams and other accidents.

Days work developed by horses employed in different modes of transportation.

MODE OF TRANSPORTATION ADOPTED.	Mean effort per horse.	Mean velocity.	Work developed in one second per horse.	Distance run in a day.	Daily work.	Remarks.
	Lbs.	Ft.	Lbs.	Ft.	Lbs. Ft.	
Chariot comtois	3,969.86 / 28.6 = 139	3.28	139	131.235	182 416.65	Results of experiments upon the draft of wagons.
Common wagon	2,756.84 / 28 = 98.4	3.28	98.4	131.235	129 135.24	
Cart	5,513.76 / 37.7 = 146.2	3.28	146.2	131.235	191 865.57	
Diligence	1,654 / 19 = 87	9.84	856	106.627	92 765 49	
Towing at a walk	Ascent.... 115.78 Descent... 83.99	2.62 3.28	303.24 330.08	84.776 84.776	98 153.65 71 208.36	Experiments upon accelerated boats upon the Canal de l'Ourcq.
				Mean	12 758.999	

"These examples show how the work developed by animal motors may vary, but at the same time they enable us to see that when we exact, but for a short period, an unusual work, it is at the sacrifice of the daily work which may be obtained from animals, without fatiguing them beyond measure, or speedily ruining them. Thus in the service of the mail boats from Paris to Meaux, the distance run for each relay was at a mean 12,375.5 feet, which was accomplished twice a day, by horses, on the ascent, and twice a day at the descent, and consequently, according to the values previously found for the resistance, the day's work of a horse in the district of Meaux, was:

At the ascent, $93.91 \times 2 \times 12{,}375.5 =$	2,324,366 lbs. ft.
At the descent, $74.2 \times 2 \times 12{,}375.5 =$	1,836,524 lbs. ft.
Total	4,160,890 lbs. ft.

But as each relay was accomplished by four horses, one of which rested for four days, the mean daily work was but 0.75 of the preceding result, or equal to 3,130,667 lbs. ft., while the table shows us that by the other modes of transportation, and without an excessive fatigue, which quickly ruins the horses, we may obtain as a mean for a day's work of a draught horse 12,758,606 pounds-feet, that is to say, a work four times as great as that obtained, with considerable loss, from horses used for hauling the mail boats of the canal de l'Ourcq." (Morin's Mechanics, Bennett.)

Messrs. Boulton and Watt estimated the power of a dray horse to be 33,000 lbs. ft. per minute for 8 hours a day.

Tredgold estimated the work of a horse to be 27,000 lbs. ft. per minute, for 8 hours a day.

Simms tested the labor of horses in raising water:

23,412 lbs. ft. per minute for 8 hours a day.
24,360 lbs. ft. per minute for 6 hours a day.
27,056 lbs. ft. per minute for 4½ hours a day.
32,943 lbs. ft. per minute for 3 hours a day.

He preferred the performances for 6 and 3 hours a day as unobjectionable to the health and durance of the horses.

Rennie found that a horse weighing 11 cwt. could draw a canal boat at a speed of 2½ miles per hour, with a pull of 108 lbs., over a distance of 20 miles per day = 23,760 lbs. ft. per minute. He estimated the average work of horses to be 22,000 lbs. ft. per minute, strong and weak.

Beardmore found that a horse eight years old, weighing 10¾ cwt., did 39,320 lbs. ft. per minute for 8 hours a day. The maximum effect of an average horse is about 25,000 lbs, ft., for 8 hours. The Bedford (England) experiments gave 20,000 lbs. feet per minute. (Manual of Rules, etc., D. K. Clark, p. 720.)

Great benefits would accrue to both the horses and their owners if the divided capital now invested in horses owned by a large number of individuals, were aggregated under one or a few large companies. A large company can afford to treat their horses more generously than individuals. In times of depression their resources will enable them to tide over their business until more prosperous times without wearing out or using up their horses by overwork. This, individual owners, unless possessing considerable capital, cannot afford to do, for the necessities of a bad season will oblige them to overwork their animals, which are then kept reduced in numbers. Horses can be fed more cheaply by a large company, for food is cheaper when purchased in large quantities and the outlay per horse for stable room, labor, etc., is also much less. The horses should not be stabled on the boat; they will do a great deal more work without injury if stabled during resting hours on shore in proper buildings.

If the horses and mules could be saved from galled shoulders by the introduction of improvements in their harness, not only would the animals be saved from great suffering, but they would perform a very much larger amount of work. This is a difficult problem as long as the animals are so severely taxed and are obliged to bear such intense and constant pressure against the shoulders as they do now.

"The condition in which the horses employed on the canals are kept is very bad economy, to say nothing of its being a disgrace to our civilization."

Respectfully submitted.

JOHN D. VAN BUREN, JR.,
State Engineer and Surveyor.

APPENDIX.

TABLE of expenditures by superintendents for ordinary repairs, showing the several purposes thereof, for the past four years.

ERIE CANAL—EASTERN DIVISION.

OCTOBER AND NOVEMBER.

	1873.	1874.	1875.	1876.
Lock tending	$17,200 68	$16,687 89	$15,647 07	$14,884 84
Labor	29,846 44	29,736 97	35,206 77	44,229 37
Materials	12,905 98	14,707 78	14,186 77	12,391 03
Merchants and mechanics	3,606 17	7,612 85	7,204 30	5,711 10
Miscellaneous	490 41	160 98	1,319 77	128 46
Clerk hire	750 00	600 00	750 00	600 00
Superintendent	1,250 00	1,000 00	1,250 00	1,000 00
	$66,049 68	$70,506 47	$75,564 68	$78,939 80

DECEMBER AND JANUARY.

	1873–74.	1874–75.	1875–76.	1876–77.
Lock tending	$4,969 03	$975 50	$1,530 87	$314 93
Labor	25,080 23	7,826 60	15,098 44	11,049 98
Materials	6,779 40	3,314 07	11,266 23	13,811 70
Merchants and mechanics	1,755 80	2,017 73	1,944 86	1,740 26
Miscellaneous	495 92	136 10	533 39	192 77
Clerk hire	862 50	525 00	750 00	600 00
Superintendent	1,337 50	1,000 00	1,250 00	1,000 00
	$41,279 88	$15,795 00	$32,363 79	$28,709 64

FEBRUARY AND MARCH.

	1874.	1875.	1876.	1877.
Contract, John Brown		$1,156 00		
Lock tending				
Labor	$4,308 20	8,280 34	$6,785 12	$6,581 89
Materials	2,064 11	5,077 87	411 49	3,807 64
Merchants and mechanics	569 57	1,558 68	1,659 83	2,476 82
Miscellaneous	25 00	286 75	151 70	287 86
Clerk hire	375 00	675 00	675 00	600 00
Superintendent	1,000 00	1,250 00	1,187 50	1,000 00
	$8,341 88	$18,284 64	$10,870 64	$14,754 21

APRIL AND MAY.

Contract, John Brown		$3,897 64	$812 36	
Lock tending	$7,821 36	4,092 94	6,081 54	$3,837 37
Labor	35,722 35	45,363 84	50,652 16	24,281 69
Materials	7,125 94	13,051 17	7,767 73	14,906 62
Merchants and mechanics	5,989 51	8,890 09	7,977 78	6,295 85
Miscellaneous	70 55	232 44	1,004 54	143 58
Clerk hire	637 50	750 00	600 00	580 64
Superintendent	1,000 00	1,212 97	1,000 00	800 00
	$58,367 21	$77,491 09	$75,846 11	$50,845 75

JUNE AND JULY.

Contract, John Brown		$2,261 72		
Lock tending	$17,150 00	14,020 74	$15,088 22	$9,406 00
Labor	21,287 91	22,984 11	21,099 46	17,315 99
Materials	10,613 14	17,400 36	6,092 55	10,428 58
Merchants and mechanics	9,132 56	4,227 54	3,102 86	4,746 18
Miscellaneous	96 09	232 01	256 03	191 79
Clerk hire	600 00	725 00	600 00	600 00
Superintendent	1,000 00	1,208 67	1,000 00	800 00
	$59,879 70	$63,060 15	$47,234 12	$43,490 54

ERIE CANAL — EASTERN DIVISION — (*Continued*).

AUGUST AND SEPTEMBER.

	1874.	1875.	1876.	1877.
Lock tending	$15,234 62	$13,125 45	$13,065 00	$9,440 00
Labor	15,860 57	25,542 17	19,384 74	19,854 62
Materials	2,651 44	7,426 46	2,675 98	17,057 35
Merchants and mechanics	1,523 44	4,723 13	4,321 70	4,235 35
Miscellaneous	159 41	420 12	478 69	172 33
Clerk hire	600 00	750 00	600 00	600 00
Superintendent	1,000 00	1,250 00	1,000 00	800 00
	$37,029 48	$53,237 33	$41,526 11	$52,159 65
Total	$270,947 83	$298,374 68	$283,405 45	$268,899 59

ERIE CANAL — MIDDLE DIVISION.

OCTOBER AND NOVEMBER.

	1873.	1874.	1875.	1876.
Lock tending	$960 00	$2,298 00	$2,240 00	$1,949 33
Labor	18,373 35	5,605 12	5,159 50	14,699 54
Materials	6,592 95	934 38	810 63	1,409 10
Merchants and mechanics	1,421 18	550 07	483 78	431 41
Miscellaneous	363 44	37 24	21 37	60 45
Clerk hire	400 00	450 00	450 00	300 00
Superintendent	750 00	750 00	750 00	750 00
	$23,860 92	$10,624 81	$9,915 28	$19,599 83

DECEMBER AND JANUARY.

	1873–74.	1874–75.	1875–76.	1876–77.
Lock tending	$141 33	$97 29	$161 37	.....
Labor	3,975 84	1,759 87	2,542 04	$1,220 85
Materials	3,639 75	988 01	54 65	4,088 57
Merchants and mechanics	129 61	255 68	128 88	243 99
Miscellaneous	413 09	25 38	17 37	52 35
Clerk hire	500 00	450 00	450 00	300 00
Superintendent	937 50	750 00	750 00	750 00
	$9,737 12	$4,326 23	$4,104 31	$6,655 76

FEBRUARY AND MARCH.

	1874.	1875.	1876.	1877.
Lock tending	.....	.....	$20 00	.....
Labor	$751 80	$943 63	927 89	$1,152 75
Materials	11,995 56	395 97	632 79	1,235 20
Merchants and mechanics	146 63	15 15	36 89	322 59
Miscellaneous	10 75	23 00	8 50	52 32
Clerk hire	450 00	450 00	562 50	300 00
Superintendent	750 00	750 00	937 50	750 00
	$14,104 74	$2,577 75	$3,126 07	$3,812 86

APRIL AND MAY.

Lock tending	$1,025 92	$517 92	$663 96	$471 69
Labor	12,437 70	8,610 42	17,456 85	9,940 55
Materials	1,292 21	2,292 22	2,161 94	2,551 03
Merchants and mechanics	1,049 96	2,702 86	1,753 45	511 24
Miscellaneous	34 15	36 07	213 96	46 12
Clerk hire	450 00	450 00	300 00	375 00
Superintendent	750 00	750 00	625 00	600 00
	$17,039 94	$15,359 49	$23,175 16	$14,495 63

ERIE CANAL — MIDDLE DIVISION — (*Continued*).

JUNE AND JULY.

	1874.	1875.	1876.	1877.
Lock tending	$3,155 00	$2,240 00	$1,840 00	$985 60
Labor	5,508 08	7,618 04	9,290 91	5,073 52
Materials	2,299 75	1,444 34	1,549 16	994 40
Merchants and mechanics	325 69	1,595 15	889 52	324 12
Miscellaneous	20 30	12 77	42 63	188 96
Clerk hire	300 00	450 00	300 00	300 00
Superintendent	750 00	750 00	875 00	400 00
	$12,358 82	$14,110 30	$14,787 22	$8,266 60

AUGUST AND SEPTEMBER.

Lock tending	$2,330 00	$2,240 00	$1,840 00	$1,160 58
Labor	5,518 41	7,611 28	10,126 31	6,266 02
Materials	1,976 24	757 87	1,156 13	1,178 99
Merchants and mechanics	768 34	311 12	442 28	344 93
Miscellaneous	46 80	17 19	52 06	76 87
Clerk hire	600 00	450 00	300 00	300 00
Superintendent	750 00	750 00	750 00	400 00
	$11,989 79	$12,137 46	$14,666 78	$9,727 84
Total	$89,091 33	$59,136 04	$69,774 82	$62,558 02

ERIE CANAL — WESTERN DIVISION.

OCTOBER AND NOVEMBER.

	1873.	1874.	1875.	1876.
Lock tending	$6,211 82	$6,525 08	$5,254 70	$5,081 35
Labor	22,519 44	18,080 95	9,796 50	23,209 16
Materials	5,550 14	13,246 93	4,556 75	7,350 71
Merchants and mechanics	2,678 82	3,544 78	1,088 01	2,115 78
Miscellaneous	241 65	543 03	567 07	1,502 68
Clerk hire	750 00	600 00	462 50	600 00
Superintendent	1,250 00	1,000 00	750 00	1,000 00
	$39,201 87	$43,540 77	$22,475 53	$40,809 68

DECEMBER AND JANUARY.

	1873–74.	1874–75.	1875–76.	1876–77.
Lock tending	$214 73	$139 26	$192 89	.....
Labor	9,486 11	4,819 71	2,536 87	$4,909 56
Materials	4,637 82	2,458 55	1,534 10	3,175 42
Merchants and mechanics	1,726 32	854 02	65 14	1,822 60
Miscellaneous	268 45	285 80	340 90	351 88
Clerk hire	912 50	600 00	300 00	600 00
Superintendent	1,520 83	1,000 00	750 00	1,000 00
	$18,766 76	$10,157 34	$5,709 40	$11,859 41

FEBRUARY AND MARCH.

	1874.	1875.	1876.	1877.
Lock tending	$2 40	.....	.....	.....
Labor	4,094 60	$2,836 59	$940 86	$4,221 96
Materials	1,550 63	1,459 77	276 67	4,174 57
Merchants and mechanics	811 32	735 91	265 90	2,119 69
Miscellaneous	111 20	181 36	1,580 10	241 01
Clerk hire	600 00	600 00	337 50	637 50
Superintendent	1,000 00	1,000 00	687 50	1,062 53
	$8,170 15	$6,813 63	$4,088 53	$12,457 26

ERIE CANAL — WESTERN DIVISION — (*Continued*).

APRIL AND MAY.

	1874.	1875.	1876.	1877.
Lock tending	$2,824 17	$1,510 76	$2,192 14	$1,361 98
Labor	41,498 37	24,839 21	29,189 70	19,008 42
Materials	6,805 77	4,884 11	5,731 26	4,917 52
Merchants and mechanics	6,866 89	4,349 67	5,687 66	3,546 00
Miscellaneous	210 05	618 42	764 34	465 16
Clerk hire	643 54	680 00	800 00	570 00
Superintendent	1,072 54	1,000 00	1,000 00	773 33
	$59,921 33	$37,777 17	$44,815 10	$30,637 41

JUNE AND JULY.

Breaks at Palmyra and Lock Berlin	.....	$13,006 77	.....	.....
Lock tending	$5,950 42	5,817 05	$2,810 00	$3,384 92
Labor	18,874 28	15,104 55	19,589 83	14,140 17
Materials	9,181 52	1,608 02	1,338 26	6,375 46
Merchants and mechanics	6,425 79	4,623 83	2,017 26	2,077 08
Miscellaneous	372 50	561 56	1,002 44	465 97
Clerk hire	600 00	600 00	600 00	600 00
Superintendent	1,000 00	1,000 00	1,000 00	800 00
	$42,404 51	$42,321 78	$28,357 79	$27,843 60

AUGUST AND SEPTEMBER.

Lock tending	$6,086 66	$5,672 94	$4,716 13	$3,862 50
Labor	16,245 70	11,944 08	20,140 13	17,065 77
Materials	2,716 79	4,373 60	15,390 27	7,131 75
Merchants and mechanics	2,865 50	2,335 30	2,273 39	2,672 65
Miscellaneous	710 16	597 63	388 53	562 22
Clerk hire	610 00	450 00	450 00	600 00
Superintendent	1,000 00	937 50	1,000 00	850 00
	$30,234 81	$25,711 05	$44,358 45	$32,744 89
Total	$198,699 43	$166,321 74	$150,304 80	$156,352 22

CHAMPLAIN CANAL — SECTIONS 1, 2, 3.

OCTOBER AND NOVEMBER.

	1873.	1874.	1875.	1876.
Lock tending	$5,819 63	$5,270 00	$5,392 67	$5,338 16
Labor	17,983 44	14,251 55	13,846 12	16,082 17
Materials	13,085 90	9,742 21	8,436 77	6,358 65
Merchants and mechanics	3,323 81	5,089 31	2,000 97	2,812 61
Miscellaneous	548 14	3,115 94	254 84	184 23
Clerk hire	450 00	300 00	450 00	450 00
Superintendent	750 00	500 00	750 00	750 00
	$41,960 92	$38,269 01	$31,131 37	$32,295 82

DECEMBER AND JANUARY.

	1873-74.	1874-75.	1875-76.	1876-77.
Lock tending	$488 67	$400 38	$283 80	$165 33
Labor	6,284 35	3,055 16	4,152 93	3,557 44
Materials	4,286 66	6,778 60	4,188 95	1,809 02
Merchants and mechanics	1,478 70	983 97	562 50	608 81
Miscellaneous	485 15	881 20	118 05	282 44
Clerk hire	487 50	300 00	450 00	450 00
Superintendent	875 00	500 00	750 00	750 00
	$16,336,03	$12,899 31	$10,506 23	$7,623 04

CHAMPLAIN CANAL — SECTIONS 1, 2, 3 — (*Continued*).

FEBRUARY AND MARCH.

	1874.	1875.	1876.	1877.
Lock tending				
Labor	$4,859 90	$2,812 57	$1,641 90	$2,649 43
Materials	3,455 11	1,719 48	2,302 76	892 28
Merchants and mechanics	1,014 70	519 73	427 96	526 05
Miscellaneous	17 97	44 50	169 11	108 75
Clerk hire	225 00	225 00	450 00	450 00
Superintendent	562 50	625 00	750 00	750 00
	$10,135 18	$5,946 28	$5,741 73	$5,376 51

APRIL AND MAY.

Lock tending	$2,481 70	$1,387 35	$2,834 06	$1,774 60
Labor	28,057 35	27,022 27	34,786 04	19,727 11
Materials	3,707 07	7,627 97	4,903 05	10,107 87
Merchants and mechanics	4,261 90	3,647 25	3,811 90	4,920 46
Miscellaneous	133 05	251 13	178 07	191 78
Clerk hire	300 00	450 00	450 00	450 00
Superintendent	500 00	750 00	750 00	600 00
	$39,441 07	$41,135 97	$47,712 30	$37,771 82

JUNE AND JULY.

Lock tending	$5,356 50	$5,280 00	$5,451 76	$4,224 00
Labor	11,890 63	11,316 84	15,936 89	9,278 58
Materials	6,025 82	2,711 35	4,987 47	2,596 77
Merchants and mechanics	1,426 30	1,365 87	1,205 00	779 40
Miscellaneous	330 27	169 36	125 36	57 14
Clerk hire	300 00	375 00	450 00	450 00
Superintendent	500 00	750 00	750 00	600 00
	$25,829 52	$21,968 42	$28,906 48	$17,985 89

AUGUST AND SEPTEMBER.

Lock tending	$5,270 00	$5,368 64	$5,368 70	$4,224 00
Labor	10,676 22	12,597 34	13,692 59	10,714 23
Materials	214 92	2,868 64	3,985 24	6,660 70
Merchants and mechanics	184 45	1,677 04	1,415 56	1,907 95
Miscellaneous	1,181 18	299 01	64 07	181 62
Clerk hire	150 00	525 00	450 00	450 00
Superintendent	500 00	750 00	750 00	600 00
	$18,176 77	$24,080 67	$25,726 16	$24,738 50
Total	$151,879 49	$144,299 66	$149,724 36	$125,791 58

OSWEGO CANAL — SECTIONS 1, 2.

OCTOBER AND NOVEMBER.

	1873.	1874.	1875.	1876.
Contract, Mead Belden	$7,129 54			
Lock tending	3,730 00	$3,819 15	$3,840 00	$2,870 00
Labor	7,553 86	6,911 76	8,626 88	8,018 30
Materials	5,846 36	4,326 96	816 26	1,754 49
Merchants and mechanics	818 16	2,009 46	236 88	318 94
Miscellaneous	85 86	54 50	166 40	21 61
Clerk hire	300 00	300 00	300 00	300 00
Superintendent	500 00	500 00	500 00	500 00
	$25,963 78	$17,921 83	$9,486 42	$8,783 34

OSWEGO CANAL — SECTIONS 1, 2 — (*Continued*).

DECEMBER AND JANUARY.

	1873-74.	1874-75.	1875-76.	1876-77.
Lock tending	$200 90	$243 33	$356 84	$78 00
Labor	3,048 32	6,164 34	1,217 88	897 75
Materials	1,504 79	6,604 87	290 73	86 87
Merchants and mechanics	576 43	427 32	204 75	59 31
Miscellaneous	50 03	25 56	17 56	83 09
Clerk hire	300 00	300 00	300 00	300 00
Superintendent	500 00	500 00	500 00	500 00
	$6,180 47	$14,265 42	$2,887 76	$2,004 99

FEBRUARY AND MARCH.

	1874.	1875.	1876.	1877.
Lock tending				
Labor	$1,832 43	$1,182 39	$1,066 84	$1,154 16
Materials	805 63	88 11	1,772 00	1,079 13
Merchants and mechanics	29 43	45 50	95 46	65 06
Miscellaneous	11 25	7 40	41 69	29 04
Clerk hire	337 50	300 00	375 00	300 00
Superintendent	562 50	500 00	625 00	500 00
	$3,578 74	$2,123 40	$3,975 99	$3,127 33

APRIL AND MAY.

Lock tending	$638 83	$867 21	$1,422 50	$1,084 60
Labor	12,266 92	7,976 88	7,297 16	3,688 63
Materials	3,909 39	598 42	1,580 38	1,126 08
Merchants and mechanics	1,614 03	732 15	1,033 20	646 97
Miscellaneous	159 18	15 50	784 16	29 98
Clerk hire	150 00	300 00	300 00	300 06
Superintendent	500 00	500 00	500 00	400 00
	$19,238 35	$10,990 16	$12,917 40	$7,226 26

JUNE AND JULY.

Lock tending	$3,750 00	$3,810 00	$2,860 00	$2,129 04
Labor	7,206 34	3,793 00	3,889 45	2,728 71
Materials	3,523 73	1,420 81	891 78	694 86
Merchants and mechanics	1,800 13	575 32	227 49	445 40
Miscellaneous	3,512 11	1,572 57	624 95	1,293 48
Clerk hire	450 00	300 00	300 00	300 00
Superintendent	500 00	500 00	500 00	400 00
	$20,242 31	$11,971 70	$9,393 60	$7,991 40

AUGUST AND SEPTEMBER.

Lock tending	$3,750 00	$3,810 00	$2,910 00	$2,654 00
Labor	6,801 87	3,778 38	2,958 85	2,461 28
Materials	3,292 91	2,454 52	1,459 36	840 79
Merchants and mechanics	657 99	528 88	469 85	347 33
Miscellaneous	21 60	62 04	30 27	36 59
Clerk hire	300 00	300 00	300 00	300 00
Superintendent	500 00	500 00	500 00	400 00
	$14,824 37	$11,428 82	$8,628 33	$7,039 99
Total	$90,028 02	$68,701 33	$47,289 50	$36,173 24

CAYUGA AND SENECA CANAL.

OCTOBER AND NOVEMBER.

	1873.	1874.	1875.	1876.
Lock tending	$1,860 00	$1,653 00	$1,740 00	$1,520 00
Labor	1,658 95	979 87	774 89	1,704 10
Materials	933 40	10 12	84 73	.....
Merchants and mechanics	47 71	80 14	53 29	514 32
Miscellaneous	125 52	0 50	0 80	.....
Clerk hire	150 00	75 00	150 00	75 00
Superintendent	250 00	250 00	250 00	250 00
	$5,025 58	$2,998 63	$3,053 71	$4,063 42

DECEMBER AND JANUARY.

	1873-74.	1874-75.	1875-76.	1876-77.
Lock tending	$20 99	$70 15	$109 65	.....
Labor	772 20	331 01	390 78	$171 45
Materials	1,279 68	19 20	575 85	.....
Merchants and mechanics	18 43	4 88	35 04	342 15
Miscellaneous	49 87	.....	1 32	.....
Clerk hire	150 00	225 00	150 00	150 00
Superintendent	250 00	250 00	250 00	250 00
	$2,541 17	$900 24	$1,512 64	$913 60

FEBRUARY AND MARCH.

	1874.	1875.	1876.	1877.
Lock tending	.....	.....	.....	.....
Labor	$990 70	$151 10	$192 00	$112 37
Materials	144 80	79 32	254 09	.....
Merchants and mechanics	.....	41 30	3 95	140 70
Miscellaneous	.....	.....	2 50	.....
Clerk hire	150 00	150 00	150 00	150 00
Superintendent	250 00	250 00	250 00	250 00
	$1,535 50	$671 72	$852 54	$653 07

APRIL AND MAY.

Lock tending	$785 66	$392 80	$785 82	$503 32
Labor	2,483 99	2,938 88	2,196 35	1,248 34
Materials	415 75	1,402 74	984 48	334 12
Merchants and mechanics	318 89	33 03	10 76	4 57
Miscellaneous	1 47	434 25	108 50	1 44
Clerk hire	150 00	75 00	150 00	150 00
Superintendent	250 00	250 00	250 00	200 00
	$4,405 76	$5,526 70	$4,485 91	$2,441 79

JUNE AND JULY.

Lock tending	$1,740 00	$1,740 00	$1,520 00	$1,300 00
Labor	1,569 48	1,062 87	1,494 95	1,260 25
Materials	509 92	1,413 36	.....	401 34
Merchants and mechanics	259 36	10 49	955 19	21 71
Miscellaneous	47 98	0 87	10 00	80 00
Clerk hire	150 00	150 00	150 00	150 00
Superintendent	250 00	250 00	250 00	200 00
	$4,526 74	$4,627 59	$4,380 14	$3,413 30

AUGUST AND SEPTEMBER.

Lock tending	$1,740 00	$1,740 00	$1,520 00	$1,300 00
Labor	977 52	677 37	2,232 60	1,329 05
Materials	408 99	208 15	.....	382 25
Merchants and mechanics	198 52	19 71	931 49	4 48
Miscellaneous	48 53	40 00	106 01	.....
Clerk hire	150 00	150 00	150 00	150 00
Superintendent	250 00	250 00	250 00	200 00
	$3,773 56	$3,085 23	$5,190 10	$3,315 78
Total	$21,808 31	$17,810 11	$19,475 04	$14,800 96

CHEMUNG CANAL.

OCTOBER AND NOVEMBER.

	1873.	1874.	1875.	1876.
Lock tending	$2,235 00	$2,160 00	$285 00	$585 00
Labor	3,799 67	2,313 45	392 10	835 05
Materials	994 74	213 22	21 09	142 24
Merchants and mechanics	311 43	44 07	9 15	25 61
Miscellaneous	38 20	17 70	129 54	22 60
Clerk hire	120 00	150 00	150 00	.....
Superintendent	250 00	250 00	250 00	125 00
	$7,749 04	$5,147 44	$1,236 88	$1,735 50

DECEMBER AND JANUARY.

	1873-74.	1874-75.	1875-76.	1876-77.
Lock tending	$16 54	.....	.....	.....
Labor	913 75	$296 95	.....	$459 00
Materials	276 11	47 94	.....	7 05
Merchants and mechanics	17 37	2 88	.....	7 30
Miscellaneous	37 02	4 94	.....	*75
Clerk hire	120 00	150 00	$150 00	.....
Superintendent	250 00	250 00	250 00	125 00
	$1,629 79	$752 71	$400 00	$599 10

FEBRUARY AND MARCH.

	1874.	1875.	1876.	1877.
Lock tending	.....	.....	.....	.....
Labor	$669 21	$142 80	.....	$170 00
Materials	45 51	7 82	.....	20 60
Merchants and mechanics	169 37	.....	.....	.....
Miscellaneous	13 15	2 84	.....	7 50
Clerk hire	150 00	150 00	$150 00	.....
Superintendent	250 00	250 00	250 00	125 00
	$1,297 24	$552 46	$400 00	$323 10

APRIL AND MAY.

Lock tending	$972 00	.....	.....	$135 80
Labor	3,910 78	$1,422 80	$1,054 85	2,228 64
Materials	1 105 29	78 85	161 17	600 27
Merchants and mechanics	425 55	62 81	97 27	124 58
Miscellaneous	35 32	3 87	62 47	9 37
Clerk hire	150 00	150 00	.....	.....
Superintendent	250 00	250 00	125 00	125 00
	$6,848 94	$1,966 83	$1,500 76	$3,223 66

JUNE AND JULY.

Lock tending	$2,160 00	$805 00	$595 00	$350 00
Labor	2,337 50	917 45	1,541 00	1,974 33
Materials	1,005 47	152 60	203 11	124 03
Merchants and mechanics	141 70	55 37	17 22	56 72
Miscellaneous	35 34	18 62	74 48	13 24
Clerk hire	150 00	150 00	.....	.....
Superintendent	250 00	250 00	125 00	125 00
	$6,080 01	$2,349 04	$2,555 81	$2,643 32

AUGUST AND SEPTEMBER.

Lock tending	$2,160 00	$780 00	$780 00	$360 00
Labor	2,268 05	1,387 25	997 05	2,584 25
Materials	325 73	83 92	48 01	2,709 01
Merchants and mechanics	115 22	22 06	55 05	151 33
Miscellaneous	24 65	177 38	85	23 98
Clerk hire	150 00	150 00	.....	.....
Superintendent	250 00	250 00	125 00	125 00
	$5,293 65	$2,849 61	$2,005 96	$5,953 57
Total	$28,898 67	$13,618 09	$8,099 41	$14,478 25

CROOKED LAKE CANAL.

OCTOBER AND NOVEMBER.

	1873.	1874.	1875.	1876.
Lock tending		$540 00		
Labor		716 50	$69 00	
Materials		10 43	2 02	
Merchants and mechanics		13 51		
Miscellaneous		4 00		
Clerk hire				
Superintendent				
		$1,284 44	$71 02	

DECEMBER AND JANUARY.

	1873–74.	1874–75.	1875–76.	1876–77.
Lock tending		$45 00		
Labor		138 00		
Materials		27 72		
Merchants and mechanics				
Miscellaneous				
Clerk hire				
Superintendent				
		$210 72		

FEBRUARY AND MARCH.

	1874.	1875.	1876.	1877.
Lock tending				
Labor	$279 85	$153 50		
Materials	87 20	66 83		
Merchants and mechanics	43 97			
Miscellaneous				
Clerk hire				
Superintendent				
	$411 02	$220 33		

APRIL AND MAY.

Lock tending	$297 00			
Labor	2,631 82	$415 75		
Materials	602 65	18 67		
Merchants and mechanics	193 82	7 38		
Miscellaneous				
Clerk hire				
Superintendent				
	$3,725 29	$441 80		

JUNE AND JULY.

Lock tending	$540 00	$120 00		
Labor	909 70	358 50		
Materials	256 74	4 32		
Merchants and mechanics	47 06	23 47		
Miscellaneous	18 90	928 49		
Clerk hire				
Superintendent				
	$1,772 40	$1,434 78		

AUGUST AND SEPTEMBER.

Lock tending	$540 00	$120 00		
Labor	1,012 77	406 35		
Materials	156 31	2 90		
Merchants and mechanics	113 83	64 13		
Miscellaneous				
Clerk hire				
Superintendent				
	$1,822 91	$593 38		
Total	$7,731 62	$4,185 45	$71 02	

CHENANGO CANAL.

OCTOBER AND NOVEMBER.

	1873.	1874.	1875.	1876.
Lock tending	$2,852 00	$2,424 00	$2,119 66	$1,743 83
Labor	2,889 92	2,416 22	1,277 44	609 86
Materials	1,061 83	378 33	398 36	384 96
Merchants and mechanics	299 05	60 95	102 00	94 71
Miscellaneous	75 49	73 38	12 01	.....
Clerk hire	450 00	150 00	150 00	.....
Superintendent	750 00	250 00	250 00	162 50
	$8,378 29	$5,752 88	$4,309 47	$2,995 86

DECEMBER AND JANUARY.

	1873–74.	1874–75.	1875–76.	1876–77.
Lock tending	.....	.....	.....	.....
Labor	$3,366 78	$762 46	$118 80	$121 50
Materials	1,548 01	151 29	42 87	84 54
Merchants and mechanics	107 14	20 51	47 44	9 40
Miscellaneous	244 02	23 18	5 37	77 06
Clerk hire	637 50	150 00	150 00	50 00
Superintendent	937 50	250 00	250 00	125 00
	$5,840 95	$1,357 44	$614 48	$467 50

FEBRUARY AND MARCH.

	1874.	1875.	1876.	1877.
Lock tending	.....	.....	.....	.....
Labor	$68 95	$53 69	$107 90	$85 36
Materials	40 00	.....	5 51	2 72
Merchants and mechanics	75 15	.....	1 67	.....
Miscellaneous	4 62	1 80	42 86	25
Clerk hire	150 00	150 00	187 50	.....
Superintendent	250 00	250 00	312 50	125 00
	$588 72	$485 49	$657 94	$213 33

APRIL AND MAY.

Lock tending	.....	$494 58	.....	.....
Labor	$5,362 50	1,109 13	$204 50	$318 41
Materials	921 80	55 73	3 68	246 56
Merchants and mechanics	329 99	10 49	3 99	43 11
Miscellaneous	85 12	22 55	.....	1 70
Clerk hire	150 00	150 00	100 00	.....
Superintendent	250 00	250 00	125 00	125 00
	$7,099 41	$2,092 48	$437 17	$734 78

JUNE AND JULY.

Lock tending	$2,368 86	$1,990 00	$216 82	.....
Labor	2,593 38	1,528 78	1,389 44	$502 94
Materials	353 10	125 90	146 45	249 25
Merchants and mechanics	131 86	19 28	22 03	13 15
Miscellaneous	118 15	2 36	37 54	30 25
Clerk hire	150 00	150 00	.....	.....
Superintendent	250 00	250 00	125 00	125 00
	$5,965 35	$4,066 32	$1,937 28	$920 59

AUGUST AND SEPTEMBER.

Lock tending	$2,494 00	$2,090 00	.....	.....
Labor	2,077 77	1,654 52	.....	$329 85
Materials	368 82	737 80	.....	146 78
Merchants and mechanics	180 42	175 41	.....	4 05
Miscellaneous	21 62	31 73	.....	58
Clerk hire	150 00	150 00	.....	.....
Superintendent	250 00	250 00	$93 75	125 00
	$5,472 63	$5,089 46	$93 75	$606 26
Total	$33,345 35	$18,844 07	$7,950 09	$5,988 32

GENESEE VALLEY CANAL.

OCTOBER AND NOVEMBER.

	1873.	1874.	1875.	1876.
Lock tending	$4,874 00	$4,249 73	$1,442 03	$2,241 49
Labor	11,236 57	10,087 49	4,126 62	5,207 78
Materials	1,103 01	1,444 90	853 61	750 51
Merchants and mechanics	1,081 08	681 20	100 88	316 37
Miscellaneous	32 20	213 16	94 51	33 90
Clerk hire	300 00	150 00	150 00	150 00
Superintendent	750 00	250 00	250 00	125 00
	$19,326 86	$17,076 47	$7,017 80	$8,825 05

DECEMBER AND JANUARY.

	1873-74.	1874-75.	1875-76.	1876-77.
Lock tending	$62 10	.....	.....	.....
Labor	7,269 92	$1,074 05	$472 50	$1,194 95
Materials	3,372 53	328 92	.....	258 77
Merchants and mechanics	928 94	105 39	.....	91 61
Miscellaneous	143 46	80 45	.....	.....
Clerk hire	406 25	150 00	75 00	150 00
Superintendent	893 75	250 00	250 00	125 00
	$13,076 95	$1,988 81	$797 50	$1,810 33

FEBRUARY AND MARCH.

	1874.	1875.	1876.	1877.
Lock tending	.....	.....	.....	.....
Labor	$3,668 13	$1,548 63	.....	$942 95
Materials	893 62	226 79	.....	144 70
Merchants and mechanics	468 15	391 88	.....	.....
Miscellaneous	79	397 68	.....	20 00
Clerk hire	129 48	150 00	.....	150 00
Superintendent	250 00	250 00	.....	125 00
	$5,410 17	$2,959 98	.....	$1,382 65

APRIL AND MAY.

Lock tending	$882 95	$186 39	$85 00	$623 02
Labor	22,812 35	10,578 52	1,824 05	8,463 92
Materials	.....	1,466 89	37 96	1,332 53
Merchants and mechanics	1 55	725 73	305 85	657 26
Miscellaneous	.....	479 84	.....	5 57
Clerk hire	.....	150 00	75 00	150 00
Superintendent	250 00	250 00	125 00	166 66
	$23,946 85	$13,837 37	$2,452 86	$11,398 96

JUNE AND JULY.

Lock tending	$4,766 33	$3,148 90	$1,829 79	$2,754 00
Labor	18,343 34	7,701 76	10,646 40	5,394 38
Materials	2,502 03	3 00	780 41	488 31
Merchants and mechanics	2,390 59	141 04	612 18	255 01
Miscellaneous	396 90	68 23	50 96	30 33
Clerk hire	300 00	150 00	150 00	150 00
Superintendent	250 00	250 00	125 00	166 66
	$28,949 19	$11,452 91	$14 194 74	$9,238 69

AUGUST AND SEPTEMBER.

Lock tending	$5,829 00	$3,664 00	$2,680 00	$2,754 00
Labor	12,374 23	5,799 29	5,919 26	4,425 26
Materials	1,761 94	1,806 58	1,722 53	778 61
Merchants and mechanics	2,122 69	801 89	767 80	376 44
Miscellaneous	212 73	119 53	179 62	16 01
Clerk hire	150 00	150 00	75 00	150 00
Superintendent	250 00	250 00	125 00	166 66
	$22,700 59	$11,591 29	$11,469 21	$8,666 98
Total	$113,410 61	$58,851 78	$35,932 11	$41,322 66

BLACK RIVER CANAL.

OCTOBER AND NOVEMBER.

	1873.	1874.	1875.	1876.
Lock tending	$3,896 00	$3,514 65	$2,663 14	$2,660 00
Labor	5,722 45	6,435 12	4,215 20	4,705 46
Materials	1,235 74	833 44	689 40	549 47
Merchants and mechanics	3,326 60	587 47	176 27	873 33
Miscellaneous	160 57	.....	13 89	36 33
Clerk hire	450 00	150 00	150 00	.....
Superintendent	750 00	250 00	250 00	250 00
	$15,471 36	$11,870 68	$8,157 90	$8,774 53

DECEMBER AND JANUARY.

	1873–74.	1874–75.	1875–76.	1876–77.
Lock tending	$15 00	$8 00	$40 00	.....
Labor	1,422 85	1,223 95	918 45	$758 88
Materials	440 86	149 48	1,137 33	247 19
Merchants and mechanics	11 72	50 06	6 25	13 48
Miscellaneous	109 88	65 19	15 71	8 12
Clerk hire	525 00	150 00	150 00	450 00
Superintendent	875 00	250 00	250 00	750 00
	$3,400 31	$1,896 68	$2,517 74	$2,227 68

FEBRUARY AND MARCH.

	1874.	1875.	1876.	1877.
Lock tending	.....	.....	.....	.....
Labor	$411 60	$814 58	$771 00	$519 88
Materials	.....	.....	17 80	14 84
Merchants and mechanics	.....	13 80	.....	4 90
Miscellaneous	792 29	10 00	7 75	19 06
Clerk hire	75 00	150 00	150 00	150 00
Superintendent	250 00	250 00	250 00	250 00
	$1,528 89	$1,237 88	$1,196 55	$958 68

APRIL AND MAY.

Lock tending	$1,582 66	.....	$860 00	$1,400 95
Labor	6,261 52	$6,538 27	4,508 19	4,576 35
Materials	782 43	1,178 58	914 58	705 43
Merchants and mechanics	516 64	488 05	317 97	433 90
Miscellaneous	172 75	14 93	18 93	40 39
Clerk hire	150 00	150 00	150 00	150 00
Superintendent	250 00	250 00	250 00	200 00
	$9,716 00	$8,619 83	$7,014 67	$7,507 02

JUNE AND JULY.

Lock tending	$3,805 00	$3,625 00	$3,500 00	$3,580 00
Labor	5,714 70	4,527 65	4,419 08	4,507 74
Materials	1,127 75	1,287 60	640 77	1,259 05
Merchants and mechanics	582 88	315 41	148 95	270 45
Miscellaneous	21 00	17 46	17 95	93 86
Clerk hire	.....	150 00	150 00	150 00
Superintendent	250 00	250 00	250 00	200 00
	$11,451 33	$10,163 12	$9,126 75	$10,061 10

AUGUST AND SEPTEMBER.

Lock tending	$3,860 00	$3,625 00	$3,500 00	$3,580 00
Labor	4,108 22	4,862 05	5,199 35	4,420 93
Materials	830 72	1,808 63	1,313 04	545 25
Merchants and mechanics	138 00	565 63	894 23	164 66
Miscellaneous	90	40 05	26 04	17 80
Clerk hire	300 00	150 00	.....	150 00
Superintendent	250 00	250 00	250 00	200 00
	$9,487 84	$11,301 36	$11,182 66	$9,078 64
Total	$51,055 73	$45,089 55	$39,196 27	$38,607 50

SUMMARY BY CANALS.

ERIE CANAL.

	1874.	1875.	1876.	1877.
Lock tending	$91,278 14	$75,360 82	$73,278 39	$56,093 04
Labor	286,389 38	249,507 48	275,874 08	244,216 81
Materials	100,379 14	95,771 58	78,092 10	116,985 64
Merchants and mechanics	47,792 60	50,903 46	41,330 49	41,737 64
Miscellaneous	4,139 92	4,402 85	8,747 39	5,177 73
Clerk hire	10,641 04	10,205 00	8,787 50	9,063 14
Superintendents	18,118 37	17,359 14	16,562 50	14,535 85
Special contracts and breaks	.....	20,322 13	812 36	.....
	$558,738 59	$523,832 46	$503,485 07	$487,809 83
Add allowances by auditor	170 64	.....	.....	1,185 58
Less disallowances by auditor	.....	571 66	256 51	.....
Total	$558,909 23	$523,260 80	$503,228 56	$488,995 41

CHAMPLAIN CANAL.

Lock tending	$19,416 50	$17,706 47	$19,330 96	$15,746 09
Labor	81,751 89	71,055 63	84,056 47	62,008 96
Materials	30,725 48	31,443 25	28,804 20	28,725 29
Merchants and mechanics	11,689 86	13,283 17	9,423 23	11,555 28
Miscellaneous	2,695 76	4,761 14	909 50	1,005 96
Clerk hire	1,912 50	2,175 00	2,700 00	2,700 00
Superintendent	3,687 50	3,875 00	4,500 00	4,050 00
	$151,879 49	$144,299 66	$149,724 36	$125,791 58
Less disallowances by auditor	160 80	269 78	150 42	3 47
Total	$151,718 69	$144,029 88	$149,573 94	$125,788 11

OSWEGO CANAL.

Lock tending	$12,069 78	$12,549 69	$11,389 34	$8,765 60
Labor	38,209 74	29,801 75	20,057 06	13,948 81
Materials	18,882 81	15,493 69	6,810 51	5,582 09
Merchants and mechanics	4,996 17	4,318 63	2,367 56	1,882 95
Miscellaneous	3,840 03	1,737 57	1,665 03	1,493 79
Clerk hire	1,837 50	1,800 00	1,875 00	1,800 00
Superintendent	3,062 50	3,000 00	3,125 00	2,700 00
Special contract	7,129 54	.....	.....	.....
	$90,028 02	$68,701 33	$47,289 50	$36,173 24
Add allowances by auditor	818 75	27 03	.....	.....
Less disallowances by auditor	.....	.....	3 45	2 25
Total	$90,846 77	$68,728 36	$47,286 05	$36,170 99

CAYUGA AND SENECA CANALS.

Lock tending	$6,140 65	$5,595 95	$5,675 47	$4,623 32
Labor	8,452 84	6,141 10	7,281 57	5,825 56
Materials	3,692 54	3,132 89	1,899 15	1,067 71
Merchants and mechanics	842 91	189 55	1,989 72	1,027 93
Miscellaneous	273 37	475 62	229 13	81 44
Clerk hire	900 00	825 00	900 00	825 00
Superintendent	1,500 00	1,500 00	1,500 00	1,350 00
	$21,808 31	$17,810 11	$19,475 04	$14,800 96
Add allowances by auditor	59 00	1 10	.....	.....
Total	$21,867 31	$17,811 21	$19,475 04	$14,800 96

SUMMARY BY CANALS—(*Continued*).

CHEMUNG CANAL.

	1874.	1875.	1876.	1877.
Lock tending	$7,543 54	$3,745 00	$1,660 00	$1,430 80
Labor	13,897 96	6,479 70	3,985 00	8,251 27
Materials	3,752 85	581 35	433 38	3,603 20
Merchants and mechanics	1,180 64	187 19	178 69	365 54
Miscellaneous	183 68	224 85	267 34	77 44
Clerk hire	840 00	900 00	450 00	.....
Superintendent	1,500 00	1,500 00	1,125 00	750 00
	$28,898 67	$13,618 09	$8,099 41	$14,478 25
Add allowance by auditor	.....	28 00	.....	.....
Less disallowances by auditor	33 22	.....	30 00	.....
Total	$28,865 45	$13,646 09	$8,069 41	$14,478 25

CROOKED LAKE CANAL.

Lock tending	$1,377 00	$825 00	.....	.....
Labor	4,834 14	2,188 60	$69 00	.....
Materials	1,102 90	180 87	2 02	.....
Merchants and mechanics	398 68	108 49	.....	.....
Miscellaneous	18 90	932 49	.....	.....
Clerk hire	.....	.....	.....	.....
Superintendent	.....	.....	.....	.....
	$7,731 62	$4,185 45	$71 02	.....
Less disallowances by auditor	72 57	.....	.....	.....
Total	$7,659 05	$4,185 45	$71 02	.....

CHENANGO CANAL.

Lock tending	$7,644 86	$6,998 58	$2,336 48	$1,743 88
Labor	15,359 30	7,554 80	3,098 08	1,967 92
Materials	4,298 56	1,449 05	596 87	1,114 81
Merchants and mechanics	1,123 61	286 64	177 13	164 42
Miscellaneous	549 02	155 00	97 78	109 84
Clerk hire	1,687 50	900 00	487 50	50 00
Superintendent	2,687 50	1,500 00	1,156 25	787 50
	$33,345 35	$18,844 07	$7,950 09	$5,938 32
Less disallowances by auditor	22 88	.....	.....	.....
Total	$33,322 47	$18,844 07	$7,950 09	$5,938 32

GENESEE VALLEY CANAL.

Lock tending	$16,414 38	$10,244 01	$6,096 82	$8,372 51
Labor	75,704 54	36,784 73	22,989 03	25,699 24
Materials	9,633 13	5,272 08	3,394 51	3,753 43
Merchants and mechanics	6,943 00	2,847 13	1,786 66	1,686 69
Miscellaneous	786 08	1,308 83	325 09	105 81
Clerk hire	1,285 73	900 00	525 00	900 00
Superintendent	2,643 75	1,500 00	875 00	874 98
	$113,410 61	$58,851 78	$35,932 11	$41,323 66
Add allowances by auditor	.....	12 00	.....	.....
Less disallowances by auditor	118 88	.....	.....	42 00
Total	$113,291 73	$58,863 78	$35,932 11	$41,280 66

SUMMARY BY CANALS — (*Continued*).

BLACK RIVER CANAL.

	1874.	1875.	1876.	1877.
Lock tending	$13,088 66	$10,872 65	$10,568 14	$11,220 95
Labor	23,641 34	24,401 62	20,026 27	19,489 18
Materials	4,417 50	5,247 73	4,712 92	3,321 23
Merchants and mechanics	4,525 84	2,019 92	1,543 67	1,460 67
Miscellaneous	1,257 39	147 63	100 27	215 56
Clerk hire	1,500 00	900 00	750 00	1,050 00
Superintendent	2,625 00	1,500 00	1,500 00	1,850 00
Add allowances by auditor	$51,055 73	$45,089 55	$39,196 27	$38,607 59
Less disallowances by auditor	20 23	43 72	75 23	677 35
Total	$51,075 96	$45,045 83	$39,121 05	$37,930 24

GENERAL SUMMARY.

	1874.	1875.	1876.	1877.
Lock tending	$174,979 46	$143,898 17	$130,270 60	$107,996 14
Labor	548,241 13	433,915 41	437,486 56	381,337 75
Materials	176,879 91	158,522 49	124,745 92	164,153 40
Merchants and mechanics	79,493 31	74,094 18	58,797 15	59,881 12
Miscellaneous	13,744 15	14,140 96	12,341 53	8,267 57
Clerk hire	20,604 27	18,605 00	16,475 00	16,388 14
Superintendent	35,824 62	31,734 14	30,343 75	26,898 31
Special contracts	7,129 54	20,322 13	812 36	
	$1,056,896 39	$895,232 50	$811,222 87	$764,922 43
Less disallowances by auditor		817 03	515 60	
Add allowances by auditor	660 27			460 51
Total	$1,057,556 66	$894,415 47	$810,707 27	$765,382 94
Add	23 15			
Less		982 55	26	
Amounts from auditor's report on expenditures are as follows:	$1,057,579 81	$893,432 92	$810,707 01	$765,382 94

Expenditures for ordinary repairs by Canal Commissioners.

CANALS.	1874.	1875.	1876.	1877.
Erie	$85,255 99	$246,400 31	$180,262 75	$41,664 66
Champlain	24,232 40	5,239 85	325 00	1,970 33
Oswego	3,739 44	4,780 91	4,556 78	4,086 83
Cayuga and Seneca	5,413 32	4,253 93	3,816 57	2,698 93
Chemung	980 06	2,415 39	2,939 45	
Crooked Lake	4,262 46	243 00		
Chenango	816 03	295 20	27 25	1,314 04
Black River	1,915 00	4,119 10	450 00	110 50
Genesee Valley	2,442 67	4,312 00	4,275 14	551 51
Oneida Lake				
Baldwinsville				
Oneida Lake Improvement				
Seneca River Towing-path				
Cayuga Inlet				
	$129,057 37	$272,059 69	$196,652 94	$52,396 80
Paid by engineers for services on ordinary repairs			*8,694 64	25,292 89
	$129,057 37	$272,059 69	$205,347 58	$77,689 69

* Previous to June, 1876, paid by commissioners.

The following are the distances from Albany and Buffalo, to the principal points on the Erie canal, as adopted by the Canal Board for the collection of tolls.

NAME OF PLACE.	Distance from Albany, miles.	Distance from Buffalo, miles.
Albany	...	352
West Troy	7	345
Schenectady	30	322
Fultonville	56	296
Little Falls	87	265
Utica	110	242
Rome	125	227
Syracuse	166	186
Jordan	185	167
Montezuma	199	153
Lyons	217	135
Palmyra	232	120
Rochester	259	93
Brockport	279	73
Albion	293	59
Medina	303	49
Lockport	321	31
Tonawanda	340	12
Lower Black Rock	348	4
Buffalo	352	...

INLAND NAVIGATION — FROM CHICAGO TO ATLANTIC PORTS.

ROUTES.	Lockage.	No. of locks.	Miles canal.	Miles river.	Miles lake.	Total distance.
1. Chicago to Montreal by the Welland and St. Lawrence canals,	553	54	71	185	1,005	1,261
2. Chicago to Montreal by the proposed Ottawa canal.....	710	69	29	402	560	991
3. Chicago to New York by Buffalo and Erie canal.....	655	72	352	202	865	1,419
4. Chicago to New York *via* Welland canal and Oswego	955	94	224	196	983	1,403
5. Chicago to New York *via* St. Lawrence and proposed Caughnawaga canals.....	717	72	158	363	1,116	1,637
6. Chicago to New York *via* proposed Ottawa and Caughnawaga canals.....	872	87	125	572	671	1,368
7. Duluth to Montreal *via* Welland and St. Lawrence canals..	572	56	72	230	1,095	1,406
8. Duluth to Montreal *via* proposed Ottawa canal.....	729	71	30	456	610	1,096
9. Duluth to New York by St. Lawrence and proposed Caughnawaga canals.....	736	74	159	417	1,206	1,782
10. Duluth to New York *via* proposed Ottawa and Caughnawaga canals	891	89	126	626	721	1,473

TOTAL TONNAGE MOVEMENT IN THE STATE OF NEW YORK—TONS MOVED ONE MILE.

The following comparative statement of the total tonnage movement in the State of New York, viz.: Over the New York State Canals, New York Central Railroad, Erie Railway, and over all the railroads in the State, together with average receipts per ton per mile, from 1860 *to* 1877, *both years inclusive. The receipts upon canals include tolls.*

YEAR.	NEW YORK STATE CANALS.		NEW YORK CENTRAL RAILROAD.		ERIE RAILWAY.		ALL THE RAILROADS IN THE STATE.	
	Tons moved one mile.	Receipts per ton per mile.	Tons moved one mile.	Receipts per ton per mile.	Tons moved one mile.	Receipts per ton per mile.	Tons moved one mile.	Receipts per ton per mile.
		Cents.		Cents.		Cents.		Cents.
1860.....	809,524,596	0.994	199,231,392	2.06	214,084,395	1.84	564,050,505	2.09
1861.....	863,623,507	1.080	237,392,974	1.96	251,350,127	1.73	660,556,875	1.96
1862.....	1,123,548,430	0.959	296,963,492	2.22	351,092,285	1.89	858,402,601	2.14
1863.....	1,034,130,023	0.876	312,195,796	2.40	403,670,861	2.09	994,039,502	2.26
1864.....	871,335,150	1.150	314,081,410	2.75	422,013,644	2.31	1,013,126,964	2.60
1865.....	843,915,779	1.100	264,993,626	3.31	388,557,213	2.76	866,647,540	3.25
1866.....	1,012,448,034	1.000	331,075,547	2.92	478,485,772	2.45	1,048,363,225	2.85
1867.....	958,362,953	0.900	362,180,606	2.53	549,888,422	2.04	1,192,818,673	1.91
1868.....	1,033,751,268	0.880	366,199,786	2.59	595,699,225	1.92	1,308,451,978	2.41
1869.....	919,153,611	0.920	474,419,726	2.20	817,829,190	1.60	1,686,342,469	2.08½
1870.....	904,351,572	0.830	*769,087,777	1.86	898,862,718	1.37	2,654,146,549	1.70
1871.....	1,050,104,125	1.020	888,327,865	1.65	897,446,728	1.47	3,154,056,525	1.70
1872.....	1,048,575,911	1.020	1,020,908,885	1.69	950,708,902	1.52	3,745,751,446	1.66½
1873.....	1,057,711,089	0.880	1,246,650,063	1.57	1,032,986,809	1.45	4,419,181,946	1.60
1874.....	938,774,141	0.730	1,391,560,707	1.46	1,047,420,238	1.31	4,495,945,932	1.45
1875.....	727,597,364	0.662	1,404,008,029	1.27	1,016,618,050	1.20	4,348,077,786	1.30
1876.....	570,969,064	0.680	1,674,447,055	1.05	1,040,431,921	1.09	4,823,162,835	1.15
1877.....	857,305,563	0.565	1,619,948,685	1.01	1,114,586,220	0.96	5,004,643,104	1.06
Totals....	16,625,182,180	.....	13,173,683,421	....	12,471,732,722	....	42,837,766,455	....

* Includes Hudson River Railroad, consolidated with the New York Central, November 1, 1869.

TRANSPORTATION AND TONNAGE OF THE ERIE CANAL.

The following table shows, for a series of years, the total charge on 100 tons up and 100 tons down; the tons arriving at tide-water from the Erie canal; the average cargoes of boats, and the lockages at Alexander's lock.

YEAR.	Tolls on 100 tons each way.	Freight on 100 tons each way.	Total charge.	Tons from Erie canal.	Average cargoes of boats.	Lockages at Alexander's lock.
1830	$1,530	$1,378	$2,908	.....	....	.....
1831	1,530	1,339	2,869	.....	....	.....
1832	1,530	1,397	2,927	....	....	.....
1833	1,241	1,174	2,415	.....	....	.....
1834	987	1,424	2,411	.....	....	.....
1835	987	1,245	2,232	497,839	38	25,798
1836	987	1,829	2,816	419,125	33	25,516
1837	987	1,626	2,613	387,506	....	21,055
1838	987	1,392	2,379	419,249	32	25,962
1839	987	1,419	2,406	386,267	32	24,234
1840	989	1,426	2,413	467,315	34	26,987
1841	987	893	1,880	532,520	35	20,320
1842	987	938	1,925	480,149	42	22,869
1843	987	691	1,678	635,345	55	23,184
1844	987	871	1,858	799,816	56	28,219
1845	987	541	1,528	959,590	63	30,452
1846	771	625	1,396	1,107,270	66	33,431
1847	771	726	1,497	1,431,252	65	43,957
1848	771	550	1,321	1,184,337	68	34,911
1849	771	531	1,302	1,266,724	68	36,918
1850	771	481	1,252	1,371,859	80	38,444
1851	658	421	1,079	1,508,677	75	40,396
1852	509	507	1,016	1,644,699	80	41,572
1853	511	567	1,078	1,851,438	84	42,967
1854	511	470	981	1,702,693	24	35,981
1855	511	470	981	1,420,715	92	30,873
1856	511	385	1,096	1,587,130	100	31,223
1857	511	395	906	1,117,199	100	22,182
1858	282	302	584	1,496,687	126	23,474
1859	211	316	527	1,451,333	143	31,905
1860	282	347	629	2,276,061	140	32,439
1861	316	339	646	2,449,609	157	31,179
1862	351	341	692	2,917,094	167	34,977
1863	351	314	665	2,647,689	177	30,071
1864	316	476	792	2,146,634	150	28,742
1865	316	406	722	2,078,361	160	26,037
1866	316	426	742	2,523,664	170	29,882
1867	316	387	703	2,226,112	156	28,654
1868	316	388	704	2,378,572	148	32,107
1869	316	416	732	2,257,689	183	24,625
1870	210	356	566	2,290,698	181	25,124
1871	210	420	630	2,648,877	178	29,725
1872	210	420	630	2,670,405	190	28,035
1873	210	420	630	2,585,355	213	24,960
1874	210	420	630	2,370,297	197	24,085
1875	175	298	473	1,914,942	197	18,761
1876	175	289	464	1,745,320	209	16,671
1877	140	314	454	2,298,008	107	21,408

The number and tonnage capacity of the boats built and registered in each year since 1857, *have been as follows:*

YEAR.	Boats.	Tons.	Average tonnage of boats.
1857	329	37,510	114
1858	255	27,830	109
1859	206	20,150	98
1860	403	48,355	120
1861	619	95,230	154
1862	850	142,470	168
1863	771	119,170	177
1864	399	56,235	141
1865	200	28,795	144
1866	485	74,630	154
1867	520	80,360	155
1868	387	64,470	167
1869	298	46,640	157
1870	269	42,400	157
1871	194	29,225	150
1872	326	57,925	178
1873	433	79,740	184
1874	249	45,960	183
1875	102	17,435	171
1876	75	10,825	144
1877	69	9,185	133
Total	7,439	1,134,540	150

GRAIN FREIGHTS OVER THE ERIE FROM CHICAGO.

The following table shows the average rate of freight for grain, per bushel, from Chicago to New York for the past seventeen years:

YEARS.	CHICAGO TO NEW YORK VIA BUFFALO.			
	Number of days in canal.	Highest rate, Chicago to Buffalo.	Highest rate, Buffalo to New York.	Average through rate of freight.
		Cents.	Cents.	Cents.
1861	8½	26	30	27½
1862	8½	17	24½	26½
1863	9	12½	25	23
1864	10	18	22	28½
1865	10	19	26	26½
1866	10	23	23	30½
1867	10	15	25	22½
1868	10	13½	24	23
1869	10	12	25	23
1870	10	10	16	17
1871	11	18	17	20½
1872	11	18	17	24½
1873	11	13	13	19
1874	11	6½	11½	15
1875	11	6½	11	11
1876	11	5	10	10
1877	11	5½	12	11

NUMBER, extent and approximate cost of structures upon the Erie canal at completion of enlargement in 1862.

Quantities.	KIND OF STRUCTURE	Price.	Amount.
48	Square feet flooring in 158 iron bridges	$0 81	$354,673 89
510	Square feet flooring in 382 wooden bridges	0 38	196,178 42
540 sets	Bridge abutments	2,750 00	1,485,000 00
540 sets	Bridge embankments, etc	1,800 00	972,000 00
57 sets	Double locks, aggregate length 9,833 feet	73,850 00	4,209,450 00
13 single	Locks, aggregate length 2,415 feet	31,560 00	441,840 00
2 single	Guard-locks, aggregate length 345 feet	23,000 00	46,000 00
5 single	Weigh-locks, aggregate length 737 feet	47,036 00	235,180 00
24,235	Lineal feet of trunk in 32 aqueducts	310 00	7,512,850 00
2,363	Lineal feet of waste-walls, waste-weirs	42 00	99,246 00
11	Stop-gates	2,000 00	22,000 00
190	Stone arch culverts, aggregate spans 1,523	4,000 00	760,000 00
94	Composite culverts, aggregate spans 435	1,700 00	150,800 00
	Total approximate cost of structure		$16,494,218 81

Dimensions and capacity of the New York State Canals.

NAME OF CANAL.	When authorized.	When completed.	Length in miles.	SIZE OF CANAL.			NO. AND SIZE OF LOCK.			Average burden of boats.	Maximum burden of boats.
				Width on surface.	Width on bottom.	Depth of water.	Number of locks.	Length between quoins.	Width in clear.		
Erie canal (original)	1817	1825	363	40	28	4	83	90	15	70	76
Erie canal, enlargement same	1835	1862	351¾	70	56	7	72	110	18	210	240
Oswego canal (original)	1825	1828	38	40	24	4	18	90	15	70	76
Oswego canal, enlargement same	1847	1862	38	70	56	7	18	110	18	210	240
Cayuga and Seneca canal (original)	1825	1828	21	40	24	4	10	90	15	70	76
Cayuga and Seneca canal, enlargement same,	1836	1862	23	70	56	7	11	110	18	210	240
Champlain canal	1817	1822	66	50	35	5	20	100	18	80	85
Champlain canal (Glen's Falls feeder)	1822	1837	12	50	35	5	12	100	18	80	85
Champlain canal (pond above Troy dam)	1822	1837	3	....	....	...	1	....	...	....	....
Black River canal and feeder	1836	1849	50	42	26	4	109	90	15	70	76
Black River canal improvement	1849	1861	42	....	....	...	1	110	18	70	76
Genesee Valley canal	1826	1861	124¾	42	26	4	112	90	15	70	76
Chenango canal	1833	1836	97	40	24	4	116	90	15	71	76
Chemung canal and feeder	1829	1831	39	42	26	4⅓	53	90	15	85	90
Oneida River improvement	1839	1850	20	80	60	4⅓	2	120	30	70	76
Oneida Lake canal	1832	1836	7	40	24	4	7	90	15	70	76
Baldwinsville canal and Seneca towing-path,	1838	1839	5¾	40	24	4	1	90	15	70	76
Crooked Lake canal	1829	1833	8	42	26	4	27	90	15	70	76

ERIE CANAL.

Total cost of construction, $49,160,986.98, up to 1876.

REMARKS.	Old canal (not now in existence).	Enlargement.
Construction authorized	April 15, 1817	May 11, 1835.
Construction commenced	July 4, 1817	August, 1836.
Construction completed	October 26, 1836	September, 1862.
Estimated cost at engineer's prices	$4,926,738	$23,402,863.
Actual cost of construction	$7,143,789.	$36,495,535. 1862.
Total feet of lockage	675⅛ feet.	654 80-100 feet.
Length from Albany to Buffalo	363 miles.	350¼ miles.
Number locks and size of chambers	83 locks, 90x15	72 locks, 110x18.
Size of prism	40 and 28x4	70 and 56x7.
Maximum dimensions of boats	78 62-100x14 46-100x3⅛ draft 1	98x17 5-11x6 5-12 draft 2.
Burden of boats	75 tons	220 tons.

Locks.

No. of lock.	Double or single.	Lift.	No. of lock.	Double or single.	Lift.	No. of lock.	Double or single.	Lift.
1	Double	15⅛	25	Double	8	49	Double	6
2	"	9⅛	26	"	8	50	"	6 11-12
3	"	11¼	27	"	8	51	"	5⅛
4	"	11¼	28	"	8	52	"	11
5	"	10	29	"	7	53	"	6
6	"	10	30	"	10⅛	54	"	7⅛
7	"	10	31	"	6	55	"	6
8	"	10	32	"	8	56	"	10
9	"	10	33	"	6	57	"	8
10	"	10	34	"	8	58	"	8
11	"	10	35	"	8	59	"	8
12	"	10	36	"	10	60	"	10
13	"	10	37	"	10	61	"	9
14	"	10	38	"	9⅛	62	"	9
15	"	10	39	"	10⅛	63	"	9
16	"	10	40	"	8	64	"	10
17	"	10	41	"	8	65	"	10
18	"	10⅛	42	"	8	66	"	9
19	"	8⅛	43	"	8	67 (Combin'd)		
20	"	10	44	"	10⅛	68 (Combin'd)		
21	"	11⅛	45	"	10⅛	69 (Combin'd)	"	55 10-12
22	"	11⅛	46	"	8	70 (Combin'd)		
23	"	8	47	"	10⅛	71 (Combin'd)		
24	"	8	48	"	10⅛	2 Gd. Blk. and Rk. and Buff.	"	2

Location of Locks.

COUNTIES.	Nos. of locks.	COUNTIES.	Nos. of locks.
Albany	1 to 18, inclusive	Onondaga	47 to 50, inclusive.
Saratoga	19 and 20	Cayuga	51 and 52.
Shenectady	21 to 25, inclusive	Wayne	53 to 60, inclusive.
Montgomery	26 to 34, inclusive	Monroe	61 to 66, inclusive.
Herkimer	35 to 45, inclusive	Orleans	
Oneida	46	Niagara	67 to 71, inclusive.
Madison			

The following shows the dates of opening and closing of the canals for each navigable season since 1824:

COMMENCEMENT AND CLOSE OF NAVIGATION OF ERIE CANAL.

Canal open.	Canal closed.	Navigable days.
1824, April 30	December 4	219
1825, April 12	December 5	238
1826, April 20	December 18	243
1827, April 22	December 18	241
1828, March 27	December 20	269
1829, May 2	December 17	230
1830, April 20	December 17	242
1831, April 16	December 1	230
1832, April 25	December 21	241
1833, April 19	December 12	238
1834, April 17	December 12	240
1835, April 15	November 30	230
1836, April 25	November 26	216
1837, April 20	December 9	234
1838, April 12	November 25	228
1839, April 20	December 16	241
1840, April 20	December 9	228
1841, April 24	November 30	221
1842, April 20	November 28	222
1843, May 1	November 30	214
1844. April 18	November 26	222
1845, April 15	November 29	228
1846, April 16	November 25	224
1847, May 1	November 30	214
1848, May 1	December 9	223
1849, May 1	December 5	219
1850, April 22	December 11	234
1851, April 15	December 5	235
1852, April 20	December 16	239
1853, April 20	December 20	245
1854, May 1	December 3	217
1855, May 1	December 10	224
1856, May 5	December 4	214
1857, May 6	December 15	223
1858, April 28	December 8	225
1859, April 15	December 12	242
1860, April 25	December 12	232
1861, May 1	December 10	224
1862, May 1	December 10	224
1863, May 1	December 9	223
1864, April 30	December 8	223
1865, May 1	December 12	226
1866, May 1	December 12	226
1867, May 6	December 20	229
1868, May 4	December 7	217
1869, May 6	December 10	218
1870, May 10	December 8	213
1871, April 24	December 1	220
1872, May 13	December 1	202
1873, May 15	December 5	205
1874, May 5	December 5	215
1875, May 18	November 30	197
1876, May 4	December 1	211
1877, May 8	December 7	214

FEEDERS.*

The following table embraces all the available feeders for supplying the Erie canal with water during the dry season, with approximate cost of each.

NAMES OF FEEDER.	When brought into use.	Source of supply.	Miles entering the canal from Albany.	Supply, cubic feet per minute.	Total cost of feeder.
Mohawk river, at Cohoes	....	Champlain canal..	.....	6,570	.....
Rexford Flats feeder	1844	Mohawk river	26	10,979	$25,000 00
Schoharie Creek feeder	1845	Creek.....	51	6,800	30,000 00
Rocky Rift feeder..	1856	Mohawk river	78	10,602	190,000 00
Little Falls feeder	1843	Mohawk river	87	12,643	12,500 00
Ilion Creek feeder	1838	Creek.....	98	800	1,000 00
Chenango canal	1836	Through lock.....	110	911	.....
Butts' creek	1838	Creek.....	124	1,400	530 00
Mohawk feeder, at Rome	1858	Mohawk river	125	11,766	25,976 36
Black River canal, at Rome	....	Through lock.....	125	1,294	.....
Oneida Creek feeder	1835	Creek.....	140	1,500	34,498 00
Cowasselon Creek feeder	1858	Creek.....	143	320	10,089 65
Erieville reservoir (100 days)	1850	Reservoir.....		2,526	36,837 03
Chittenango Creek feeder	1840	Creek and outlet,	152	250	10,889 37
Cazenovia Lake reservoir (100 days)	1867	Reservoir		3,115	10,884 73
De Ruyter reservoir, through (100 days)	1863	Reservoir		3,891	158,378 20
Limestone creek	1852	Creek and outlet,	158	500	27,335 41
Orville (Butternut creek) feeder	1858	Creek.....	161	500	45,000 00

* Reservoir proper, in progress, nearly completed.

FEEDERS* — *Continued.*

NAMES OF FEEDER.	When brought into use.	Source of supply.	Miles entering the canal from Albany.	Supply, cubic feet per minute.	Total cost of feeder.
Jamesville reservoir (60 days)	....	Butternut creek ..	.....	2,000	*150,000 00
Camillus feeder	1843	Creek	175	1,500	11,327 68
Skaneateles reservoir	1844	Reservoir.....	185	7,520	14,927 55
Genesee River feeder	1826	Genesee river.....	259	350	42,750 54
Genesee Valley canal	1842	Through lock	259	861	.....
Oak Orchard Creek canal	1840	Creek.....	303	1,400	29,722 42
Lake Erie, Buffalo	1856	Lake.....	350½	35,000	.....
Owasco Lake feeder	....	Lake.....	.....	4,033	27,349 23
Nine Mile Creek feeder	....	Creek.....	.....	800	3,628 26
Otisco Lake reservoir	....	Lake.....	.....	5,146	43,753 25
Putnam Brook feeder	....	Creek.....	.....	200	.....
Carpenter's Brook feeder	....	Creek.....	.....	200	.....
Oriskany Creek feeder	1871	Creek.....	.....	4,300	32,340 74
Total cost enlargement feeders†					$974,718 42
Total cost original Erie Canal feeders					101,147 00

* Reservoir proper, in progress, nearly completed.

† Approximate.

APPENDIX.

LATERAL CANALS.

DESCRIPTION, DIMENSIONS, COST AND CAPACITY.

LATERAL CANALS.

Champlain Canal and Glens Falls Feeder.

Construction authorized	April 15, 1817.
Glens Falls feeder authorized	April, 1822.
Estimated cost of canal at engineer's prices	$871,000.
Navigation opened from Fort Edward to Lake Champlain	November 24, 1819.
Canal completed from Waterford to Lake Champlain	1822.
Canal, cost of construction up to 1832	$921,011.
Feeder, cost of construction up to 1837	$91,944.
Total cost of both, including improvements, exclusive of ordinary repairs, June, 1868	$2,378,910.
Number of locks on canal, 20; feeder, 13	Size, 110x18 and 100x15
Length of canal, 66 miles; feeder, 7 miles; pond, 5 miles	78 miles.
Size of prism, canal and feeder	40 26x4.
Size authorized, chapter 213, Laws 1860	50 35x5.
Size authorized, chapter 788, Laws 1870	58 44x7.
Total cost of canal and feeder up to September 30, 1876	$673,028.73.

Locks.

Champlain Canal.						Glens Falls Feeder.			
No.	Lift.	No.	Lift.	No.	Lift.	No.	Lift.	No.	Lift.
1	10¾	8	8¾	15	8	1	10	8	10
2	10¾	9	10	16	7	2	10	9	10
3	8⅝	10	9¾	17	8¼	3	10	10	10
4	9	11	11¼	18	9	4	10	11	11
5	9	12	9	19	9	5	10	12	11
6	9	13	10¼	20	10	6	10	13	10
7	9¼	14	8			7	10		

Black River Canal, Feeder and Black River Improvement.

Construction authorized	April 19, 1836.
Construction commenced	January, 1838.
Estimated cost at engineer's prices	$1,068,437.
Estimated cost at contract prices	$2,431,669.
Canal completed	1849.

Cost of construction to 1876..... $3,885,149 23.
Number and size of locks ..... 109 locks, 90x15.
Length of canal to Lyons Falls..... 35 miles.
Length of river to Carthage, and fall..... 42 miles 9½ feet.
Size of prism of canal and feeder ..... 42 and 28x4.
Length of navigable feeder, and fall..... 10½ miles; 6 10/100 feet.
Burden of boats ..... 45 to 50 tons
Lockage of canal ..... 1,082½ feet.

Locks.

No.	Lift.	No.	Lift.	No.	Lift.	No.	Lift.	No.	Lift.
1	10	23	10	45	10	67	10	89	10
2	10	24	10	46	10	68	9	90	10
3	10	25	10	47	10	69	9	91	12
4	10	26	10	48	10	70	9	92	10
5	10	27	10	49	10	71	10	93	10
6	10	28	10	50	10	72	10	94	10
7	10	29	10	51	10	73	10	95	10
8	11	30	10	52	10	74	10	96	10
9	12	31	10	53	10	75	10	97	10
10	11	32	10	54	10	76	10	98	10
11	11	33	10	55	10	77	10	99	10
12	11	34	10	56	10	78	10	100	10
13	8	35	10	57	10	79	10	101	10½
14	8	36	10	58	10	80	9	102	10½
15	8	37	10	59	10	81	9	103	4
16	10	38	10	60	10	82	9	104	10
17	8	39	10	61	10	83	9	105	10
18	10	40	10	62	10	84	9	106	11
19	8	41	10	63	10	85	10	107	11
20	10	42	10	64	10	86	11½	108	12
21	10	43	10	65	10	87	10	109	12
22	10	44	10	66	10	88	10		

ONEIDA LAKE CANAL AND ONEIDA RIVER IMPROVEMENT.

Cost of canal up to 1876, $710,045,95.

REMARKS.	Oneida Lake canal.	Oneida river improvement.
Construction authorized	March 22, 1832	April 29, 1839.
Estimated cost at engineer's prices,	$40,000	$100,049.
Construction completed	1836	1850.
Cost of construction	$78,829	$79,346.
Purchased of company by State	May 11, 1840	For $50,000.
Enlargement of locks authorized	Chapter 46, Laws of 1860	
Number and size of new locks	7, 110x18	2, 120x30½.
Size of prism	70x56x7	80x60x4½.
Length	7 miles	20 miles.
Feet of lockage	60¼ feet	No. 1, 3 feet; No. 2, 3¼ ft.

Locks.

PRESENT OLD LOCKS.						ENLARGED LOCKS AUTHORIZED.					
No.	Lift.	No.	Lift.	No.	Lift.	No.	Lift.	No.	Lift.	No.	Lift.
1	7½	4.....	10	6.....	7¼	1....	8½	4.....	10¾	6.....	8
2.....	8½	5	9½	7.....	6 1-12	2....	8¾	5... ..	9½	7.....	7½
3.....	9					3....	8				

OSWEGO CANAL.

Total cost, $4,264,902 31.

REMARKS.	Oswego canal.	Enlarged Oswego canal.
Construction authorized.....	April 20, 1825.....	April 15, 1854.
Enlargement of locks.....	.....	Chapter 262, Laws of 1847.
Estimated cost at engineer's prices,	$227,000..	$1,926,336.
Estimated cost at contract prices...	$437,000.....	$2,051,190.
Construction completed.....	December 10, 1828.....	September, 1862.
Cost of construction.....	$565,437.....	$2,925,513.
Number of locks, and size.....	18, 90x15.....	17, 110x18.
Feet of lockage.....	154.85 feet.....	154.85 feet.
Average cost of one lock.....	$10,000..... ...	$31,000.
Size of prism of canal..	40 and 26x4.....	70 and 36x7 feet.
Guard locks	Six	Five.
Burden of boats.....	50 to 75 tons.....	230 tons.
Length of canal	38 miles.....	38 miles.

Locks.

No.	Lift.	No.	Lift.	No.	Lift.	No.	Lift.	No.	Lift.
1.....	11	4	9.68	8.....	11¼	12 ...	11¼	16.....	8¾
2.....	11	5		9.....	7¾	13.....	5.65	17	10½
3.	10½	6.....	7	10.....	9	14.....	9½	18.....	9¼
		7.....	5.866	11.....	11¾	15.....	5¾		

CAYUGA AND SENECA CANAL — CAYUGA INLET.

Total cost, $1,807,113.

REMARKS.	Cayuga and Seneca canal.	Cayuga inlet.
Construction authorized, enlargement of locks.....	April 20, 1825..... ..	May 25, 1836.
Enlargement of prism..... ...	....	April 15, 1854.
Estimated cost at engineer's prices,	$811,188.....	$150,000.
Estimated cost at contract prices..	$795,273.....	$160,396.
Canal completed.....	November 15, 1828.....	September, 1862.
Cost of construction.....	$1,306,542.....	$214,000.
Number of locks, and size.....	11, 110x18..	1, 110x18.
Feet of lockage...	83½ feet.....	
Length and size of prism.....	....	$24¾ miles 70 and 56x7.

Locks.

No.	Lift.	No.	Lift.	No.	Lift.	No.	Lift.	No.	Lift.
1.....	7.28	4.....	9	6	9.60	8.....	5.70	10.....	10
2.....	7	5.....	9	7.....	6	9.....	10	11.....	3
3.....	10								

CROOKED LAKE CANAL.

Construction authorized	April 11, 1829.
Construction commenced	April, 1830.
Estimated cost at engineer's prices	$119,198.
Estimated cost at contract prices	$95,820.
Canal completed	October 10, 1833.
Cost of construction	$403,697.
Number of locks, 27; size	90x15 feet.
Size of canal prism	42 and 26x4.
Length of canal	8 miles.
All the locks are composite.	
Feet of Lockage	277 83-100 feet.

Locks.

No.	Lift.	No.	Lift.	No.	Lift.	No.	Lift.	No.	Lift.
1.....	10.82	7.. ...	10.16	13....	9.41	19....	10.18	25.....	10.15
2.	10.19	8.....	10.28	14....	9.86	20....	9.88	26.....	10.58
3.....	10.21	9.....	10.30	15....	10	21....	10.06	27.....	10.43
4.....	10.26	10.....	9 49	16....	10.29	22....	10.31		*4.59
5..... ...	10.08	11.....	9.87	17....	9,94	23....	10.67		
6.....	10.14	12.....	9.63	18..	9.73	24....	10.37	Total..	277.89

CHEMUNG CANAL AND FEEDER.

Construction authorized	April 15, 1829.
Estimated cost, engineer's prices	$331,235.
Estimated cost, contractor's prices	$291,831.
Construction completed	September, 1831.
Cost of construction, 1831	$314,395.
Cost of construction	$1,643,141.
Length and size of main canal	23 miles; 42x28x5 ft.
Length and size of feeder	16 miles; 41x26x4 ft.
Number and size of locks on canal	49 locks; 90x15 feet.
Number and size of locks on feeder	4 locks; 90x15 feet.
Kind of locks	Wood.

* Guard-lock over lower miter sill, December 20, 1858.

Cost of each first set, $1,650; age of lock..... 9 years.
Cost of each second set, $5,500; age of lock... 19 years.
Cost of each third set, $8,484; completed .... September 9, 1863.

Locks.

No.	Lift.	No.	Lift.	No.	Lift.	No.	Lift.	No.	Lift.
1.....	10.1	11.....	9.11	21....	10	31....	10.3½	41.....	10.6
2.....	10.6	12.....	10	22....	10.3	32. .	9.10	42.....	9.5
3.....	10.7	13.....	9.11	23 ...	9.7	33....	10	43.....	10.2
4.....	10.7	14.....	10	24....	10 4	34....	10	44.....	10.3
5	10.3	15.....	10	25....	10.2	35....	10	45.....	9.5
6.....	10.3	16.....	10	26....	9	36....	10.1	46.....	9.1
7.....	10.5	17.....	10.1	27...	10.9	37....	10	47.....	8.10
8.....	9.4	18.....	10.3	28....	10.3	38....	10	48.....	7.3
9.....	10.3	19.....	10.3	29 ...	9.8	39...	10.1	49... ..	13.3
10.....	10.3	20.....	9.7	30...	10.2	40....	10		

CHENANGO CANAL.

Construction authorized..... February 23, 1833.
Construction commenced..... July, 1834.
Construction, estimated at engineer's prices... $1,960,450.
Construction, estimated at contractors' prices.. 1,859,849.
Construction completed..... October, 1836.
Construction, actual cost..... $4,542,107.
Number and size of locks ..... 116 locks; 90x15 feet.
Size of prism .... 40 and 28x4.
Kind of locks..... Rubble stone.
Average cost of one lock..... $8,000.
Length of main line of canal..... 97 miles.
Feet of lockage..... 1,015⅛.
Burden of boats..... 50 to 70 tons.

Locks.

No.	Lift.	No.	Lift.	No.	Lift.	No.	Lift.	No.	Lift.
1.....	5	25.....	9	48....	9	71....	9	94 ...	8
2.....	6	26.....	9	49.. .	10	72....	9	95	8
3.....	8	27.....	10	50....	10	73....	9	96	8
4.....	8	28.....	10	51....	10	74....	9	97	8
5.....	10	29.	10	52....	10	75.. .	9	98	6
6.....	10	30.....	10	53....	10	76....	10	99	10
7.....	10	31.....	10	54....	10	77....	6	100	10
8.....	9	32.....	10	55....	10	78....	5	101	10
9.....	9	33.....	10	56. .	10	79....	5	102	6
10.....	8	34.....	10	57. ..	10	80....	8	103	10
11.....	8¼	35.....	10	58....	10	81....	8	104	10
12.....	8.4	36.....	10	59 ..	10	82....	9	105	7
13.....	8.4	37.....	10	60	10	83	9	106	6
14.....	8.4	38.....	10	61....	10	84....	8	107	10
15.....	8.4	39... ..	9	62	10	85....	6	108 ...	7
16.....	7	40.....	9	63....	10	86....	10.3	109 ...	6
17.... ..	7	41.....	9	64....	10	87....	10	110	9
18.....	8	42.....	9	65....	10	88....	10.6	111	12
19	10	43.... .	9	66....	10	89....	7	112	7
20.....	10	44.....	9	67....	9.3	90....	8	113	9.8
21.....	9.6	45.....	9	68....	9.3	91....	8	114 ...	13
22.....	9	46.....	9	69...	9.3	92. ..	8	115 ...	.....
23.....	9	47.....	9	70....	9	93....	6	116	.....
24.....	9								

GENESEE VALLEY CANAL AND DANSVILLE BRANCH.

Construction authorized	May 6, 1836.
Estimated cost at engineer's prices	$2,002,285.
Estimated cost at contract prices	$4,900,122.
Completed to Dansville	November 1, 1842.
Completed to Olean	November, 1856.
Completed to Mill Grove pond	December, 1861.
Total cost of canal and reservoirs	$6,433,842.
Length of canal and side-cut	124¾ miles.
Size of prism of same	42, 26x4 feet.
Burden of boats	50 to 55 tons.
28 stone locks, cost each	$10,000.
73 composite locks, cost each	$8,000.
11 wood locks, cost each	$5,000.
Total number and size of locks	112 locks 90x15 feet.

Locks.

No.	Lift.	No.	Lift.	No.	Lift.	No.	Lift.	No.	Lift.
1	14 6	24	9	47	10	70	7.9	93	8
2	6	25	10	48	10	71	11	94	8
3	10	26	10	49	10	72	8	95	9
4	10	27	11	50	12	73	8	96	10
5	10	28	8	51	12	74	9	97	10
6	7	29	12	52	12	75	9	98	11
7	6.1⅝	30	10	53	12	76	10	99	11
8	7	31	10	54	12	77	10	100	10
9	11.6	32	10	55	12	78	10	101	8.9
10	11.6	33	10	56	12	79	10	102	8
11	11	34	10	57	12	80	8	103	9
12	10	35	10	58	12	81	10	104	9
13	11	36	10	59	12	82	11	105	9 abandoned.
14	11	37	8	60	12	83	11	106	11 abandoned.
15	11	38	10	61	8	84	11		
16	11	39	11	62	12	85	11		
17	11	40	11	63	6	86	11	Dansv'le Branch.	
18	10	41	11	64	12	87	11	1	
19	8	42	10.9	65	9	88	11	2	
20	11	43	10	66	9	89	11	3	
21	10	44	10.6	67	9	90	11	4	83.6
22	10	45	9	68	10	91	8	5	
23	11	46	10	69	10	92	8	6	
								7	
								8	

The total tonnage of all the property on the canals, ascending and descending, its value and the amount of tolls collected for the forty-one years preceding, is as follows:

YEAR.	Tons.	Value.	Tolls.
1837	1,171,296	$55,809,288	$1,292,623
1838	1,333,011	65,746,559	1,590,911
1839	1,435,713	73,399,764	1,616,382
1840	1,416,046	66,303,892	1,775,747
1841	1,521,661	92,202,929	2,034,882
1842	1,236,931	60,016,608	1,749,196
1843	1,513,439	76,276,909	2,081,590
1844	1,816,586	90,921,152	2,446,374
1845	1,985,011	100,553,245	2,646,181
1846	2,268,662	115,612,109	2,756,106
1847	2,869,810	151,663,428	3,635,381
1848	2,796,230	140,086,157	3,252,212
1849	2,894,732	144,732,285	3,268,226
1850	3,076,617	156,397,929	3,273,899
1851	3,582,733	159,981,801	3,329,727
1852	3,863,441	196,603,517	3,118,244
1853	4,247,852	207,119,570	3,204,718
1854	4,165,862	210,284,312	2,773,566
1855	4,022,617	204,390,147	2,805,077
1856	4,116,082	218,327,062	2,748,203
1857	3,344,061	136,997,018	2,045,641
1858	3,665,192	138,568,844	2,110,754
1859	3,781,684	132,160,758	1,723,945
1860	4,650,214	170,849,198	3,009,597
1861	4,507,635	130,115,893	3,908,785
1862	5,598,785	203,234,331	5,188,943
1863	5,557,692	240,046,461	4,645,207
1864	4,852,941	274,400,639	3,983,982
1865	4,729,654	256,237,104	3,839,955
1866	5,775,220	270,963,676	4,436,639
1867	5,688,325	278,956,712	4,088,058
1868	6,442,225	305,301,929	5,246,563
1869	5,859,080	249,281,284	3,778,501
1870	6,173,769	231,836,176	2,611,578
1871	6,467,888	238,767,691	3,100,838
1872	6,673,370	220,913,321	3,072,411
1873	6,364,782	191,715,500	2,976,718
1874	5,804,588	196,674,322	2,637,071
1875	4,859,858	145,008,575	1,590,022
1876	4,172,129	113,090,379	1,340,204
1877	4,929,875	128,923,890	880,896

LOCKS.

NAME OF CANAL.	Length in miles of canals.	Number of locks.	Feet of lockage.	Feet lockage per mile.
Erie Canal (72 double)	352 16	72	654.80	1.86
Navigable feeders of same	3.85	....	.....	.....
Port Schuyler (side cut)	.35	.....	.....	.....
Albany basin	.77	.....	.....	.....
Mohawk feeder	.50	.....	.....	.....
Champlain Canal	66.00	33	179.50	2.72
Pond above Troy dam	3.00	.....	.....	.....
Glen's Falls feeder and pond	12.00	.....	132.00	11.00
Black River canal	35.33	109	1,082.25	30.63
Black River feeders	13.47			
Black River improvement	42.50	1	.....	.....
Oneida Lake canal	5.00	7	62.00	10.33
Oswego canal	38.00	18	154.85	4.07
Oneida River improvement	20.00	2	7.85	.39
Seneca River towing-path	5.75	.....	.....	.....
Baldwinsville canal	12.50	1	8.00	8.00
Cayuga and Seneca canal	22.77	11	76.61	3.34
Crooked Lake canal	8.00	27	277.83	34.73
Chemung canal and feeder	39.00	53	504.88	12.95
Cayuga inlet	2.00	1	.....	.....
Chenango canal	97.00	116	1,015.33	10.46
Genesee Valley canal and feeder	113.50	114	1,045.39	8.96
Dansville branch	11.00		82.50	7.50
Genesee River feeder at Rochester 2.25	3.00	....	.....	.....
Genesee River feeder at Oramel .75				
	906.95	565	5,283.79	5.09

The names and extent of those canals which the Legislature is prohibited from selling, leasing or otherwise disposing of, by section 6 of article 7 of the Constitution, as amended, together with the feeders connected therewith, and clearly necessary to furnish the requisite supply of water for the same, are as follows:

ERIE CANAL.

Name of canal.	Miles.
Erie canal, Eastern Division	106.24
Erie canal, Middle Division	97.02
Erie Canal, Western Division	148.90
Albany Basin	0.77
Port Schuyler and West Troy side-cut	0.35
Total	353.28

Feeders.

Mohawk river, at Cohoes	
Rexford Flats feeder	0.39
Schoharie Creek feeder	0.63
Rocky Rift feeder	3.92
Little Falls feeder	0.69
Ilion Creek feeder	
Butts Creek feeder	
Oriskany Creek feeder	0.53
Mohawk river, at Rome	0.05
Black River canal (navigable)	17.054
Oneida Creek feeder	
Cowasselon Creek feeder	
Limestone Creek feeder	0.80
Butternut Creek feeder, Orville	1.55
Camillus Creek feeder	1.00
Chittenango Creek feeder	
Cazenovia Lake reservoir	
Erieville reservoir	
De Ruyter reservoir	
Jamesville reservoir (on Butternut creek)	
Nile Mile Creek feeder	
Carpenter Brook feeder	
Skaneateles Lake reservoir	
Otisco Lake reservoir	
Putnam Brook feeder	
Owasco Creek feeder	
Genesee River feeder	3.00
Oak Orchard Creek feeder	
Lake Erie	

OSWEGO CANAL.

Name of canal.	Miles.
Syracuse to Oswego	38.00

Feeders.

Seneca river	
Oneida river	
Erie canal	

CAYUGA AND SENECA.

Montezuma to Cayuga	22.77

Feeders.

Seneca lake	
Erie canal	

CHAMPLAIN CANAL.

Junction to Whitehall and West Troy side-cut	66.00
Pond above Troy dam	3.00
Total	69.00

Feeders.

Mohawk river, at Cohoes	
Hudson river, at Saratoga dam	
Glen's Falls feeder and pond above	12.00
Wood creek	

SUMMARY.

Erie canal	351.78
Oswego canal	38.00
Cayuga and Seneca canal	22.77
Champlain canal	69.00
Total to be retained for purposes of navigation	481.55

Add portions of present navigable canals necessary to be retained as feeders.

Black River canal	*17.04
Glen's Falls feeder and pond above	12.00
Chenango canal	8.00
Genesee Valley canal	
Total to be retained for purposes of navigation, and for feeders	37.04

*Twelve miles of feeder and 5.04 miles of canal proper.

From the foregoing it will be observed that, of the 906.95 miles of canal and of navigable feeders owned by the State, there remain 388.36 miles subject to such disposition as the Legislature may authorize or direct.

From the foregoing it will be observed that there are 906.95 miles of navigable canals and feeders; there are also 19.13 miles of feeders not navigable, making a total of 926.08 miles of canal and feeders, under the supervision of this department, exclusive of the Chenango Canal extension, work upon which has been practically suspended.

The total length of navigable canals and feeders, together with the lakes and rivers artificially connected therewith, in the State of New York, is as follows:

	Miles.
Total length of artificial canals and feeders	906.95
Hudson river, from New York to Waterford	155.00
Lake Champlain, from Whitehall to Rouse's Point	111.00
Oneida lake	22.00
Cayuga lake	39.00
Seneca lake	35.00
Crooked lake	19.00
Delaware and Hudson canal (in this State) belongs to a corporation	87.00
Junction canal belongs to a corporation	18.00
Total	1,392 95

ANNUAL REPORT

OF THE

DIVISION ENGINEER, EASTERN DIVISION, NEW YORK STATE CANALS, 1877.

DIVISION ENGINEER'S OFFICE,
ALBANY, *October* 1, 1877.

Hon. JOHN D. VAN BUREN, Jr., *State Engineer and Surveyor:*

SIR.— I have the honor to transmit herewith my annual report for the fiscal year ending September 30, 1877.

Yours respectfully.

E. SWEET, JR.,
Division Engineer.

DESCRIPTION OF THE EASTERN DIVISION.

The eastern division now consists of the Erie canal, from Albany to the east line of Oneida county, and the whole of the Champlain canal, including their basins, side-cuts, river improvements and feeders.

Their navigable extent is as follows:

	Miles.
Erie canal, Albany to Utica	106.243
Port Schuyler side-cut	.35
Albany basin	.77
Mohawk feeder (north side), Little Falls	.50
Champlain canal, including Waterford side-cut, and Cohoes and Saratoga dams	66.00
Pond above Troy dam	3.00
Glen's Falls feeder and pond	12.00
Total	188.863

Extent of feeders not navigable.

	Miles.
Mohawk river, at Rexford Flats	.39
Mohawk river, south side, Little Falls	.19
Mohawk river, at Rocky rift	3.92
Schoharie creek	.63
Total	5.13

WATER SUPPLY.

The portion of the Erie canal between Little Falls and the western limit of this division is supplied, through the Rome level, from the upper water sheds of the Mohawk and Black rivers, a portion of which is stored in artificial reservoirs, all of which are upon the middle division.

From Little Falls to Albany, though there has been an unusual number of lockages, there has been a surplus of water available through the river feeders, and I do not apprehend any deficiency of supply will ever exist on the eastern declivity of the Erie canal, except from the summit level.

The water supply of the Champlain canal is ample and secure beyond any probable contingency. Its summit level controls the entire drainage of the Hudson above Glen's Falls, which is supplemented on the north, at Fort Ann, by the waters of Wood creek, and on the south, at Fort Miller, by the small drainage of the Hudson, between that point and Glen's Falls, and at Cohoes, by the waters of the Mohawk.

The only difficulty attending the supply of water upon this canal, is that from changes of surface declivity on its long level, between locks 9 and 10, consequent upon the frictional resistance of its shallow and tortuous channel, when water is rapidly drawn for lockages or other purposes. These changes of surface declivity have occasioned frequent detentions to navigation upon this level, and I would suggest the advisability of raising its embankments and increasing the capacity of its wate-weirs sufficiently to remedy this difficulty.

ORDINARY REPAIRS.

The ordinary repairs upon this division have been performed in such a manner as to greatly improve the general condition of the structures and to fully maintain the efficiency of the canals within its limits. These results have been attained with a smaller expenditure than has been required for this class of repairs for many years.

No serious detention to the navigation of this division of the Erie canal has occurred, except that due to the failure of a part of the old floor timbers in the eastern span of Spraker's aqueduct. This was immediately repaired, in a temporary manner, so as to permit the resumption of navigation on the following day.

The result of the vertical discharge of the water in this level, into the channel beneath this part of the aqueduct, was to undermine the east abutment to such an extent as to render its reconstruction advisable before the next season of navigation.

There have been three breaches in the banks of the Champlain canal during the past season; one at Stillwater, one at Coveville, and one on

the feeder at Glen's Falls. Neither of these breaks required more than twenty-four hours for its temporary repair.

Slight detentions also occurred on the Champlain by an accident to a gate at the Upper Saratoga guard-lock, and by the undermining of the walls of locks 5 and 13 on the Glen's Falls feeder.

The first two breaks resulted in serious damage to the structures at which they occurred, and the last named accidently disclosed defects in the founding of the feeder locks, which should be carefully investigated and remedied before the resumption of navigation next year.

There have been some important works executed and paid for as ordinary repairs during the year.

The drops in the artificial channel of the creek at East Frankfort have been thoroughly repaired, including the renewal of part of the aqueduct foundation and the construction of a new apron at the upper drop.

These repairs involved extensive pumping operations, and have been thoroughly executed.

The aqueducts at Yatesville, Lasher's, and Hoffman's ferry, have been retrunked with Georgia pine timber.

The channel of Chucktenunda creek, at Port Jackson, has been excavated to a depth of about four feet, from its mouth to a point 300 feet above the canal culvert.

A dock of rubble masonry, about 300 feet in length, has been constructed in front of the State repair shops at Cohoes.

Five thousand lineal feet of permanent drains have been constructed along the canal in West Troy, to drain cellars inundated by canal leakage, and which have completely effected the object for which they were designed.

The culvert at Coveville, partly destroyed by the break in May last, has been thoroughly repaired and lengthened.

The bottoms of locks 7, 15 and 18 have been concreted anew and replanked.

EXTRAORDINARY REPAIRS.

The only repairs of this class undertaken, during the year, were those authorized by the resolution of the Canal Board, dated December 5, 1876, under act chapter 425, Laws of 1876, and consisted of rebuilding two culverts of the Erie canal, one near lock 24 and one at Crescent; rebuilding lock 6 of the Champlain canal; building three new iron bridges; one at Exchange street, Albany; one at Port Schuyler, and one at Liberty street, Schenectady, and rebuilding abutments on the Champlain canal. All these works, except the Champlain abutments, were completed before the opening of navigation last spring. Of the latter, forty-two have been entirely, and seven partially, rebuilt, and the

materials have nearly all been delivered for the completion of the entire work.

The estimated and actual cost of these various works were as follows:

STRUCTURE.	Estimated cost	Actual cost.	Remarks.
Rebuilding culvert near Lock No. 24	$2,948 00	$5,009 31	.....
Rebuilding culvert at Crescent	1,194 60	1,307 62	.....
Rebuilding Lock 6, Champlain canal	10,719 50	15,140 76	.....
Building wrought-iron bridge at Exchange street, Albany	1,479 50	1,307 67	.....
Building wrought-iron bridge at Port Schuyler	3,594 60	3,596 45	.....
Building wrought-iron bridge at Liberty street, Schenectady	2,296 30	2,423 61	.....
Rebuilding Champlain canal abutments, first division	12,056 00	7,905 16	Incomplete.
Rebuilding Champlain canal abutments, second division	20,185 00	11,677 96	Incomplete.

The fact that the final costs of three of these works considerably exceeds the estimates, resulted principally from the following reasons: A severe frost set in immediately on the close of navigation, and continued without intermission, and with but little snow, through the month of December. During this period nearly the whole of the excavation had to be accomplished. The frost penetrated during the night as deep as could be excavated the following day, and it is only owing to the judicious use of powder that the item of excavation was not far greater than it is. The cost of embankment was also increased by it being found necessary to borrow material, the larger part of that coming from the excavation being too full of frozen lumps to be deemed a proper material to use.

On lock 6 an accurate account of the various items of work was kept, and I append an abstract therefrom in illustration of the above:

	Estimated.		Actual.		Difference.	Total.
	Amount.	Cost.	Amount.	Cost.		
Excavation	$2,200 00	$440 00	$4,741 00	$3,077 00	$2,637 00	
Embankment	2,200 00	440 00	4,741 00	1,675 00	1,235 00	
						$3,872 00

The increase in amount arose from the fact that the bank was originally founded on swamp mud, which caved badly while the foundation was being put in.

The excess in actual cost over the estimate was $4,408.13, of which $3,872 is accounted for as above, leaving the increase on other items but $536.13, of which fully $400 was invested in tools, derricks, etc., left on hand on the completion of the work.

Special Repairs Recommended.

The guard-lock on the north side of the Mohawk river, at Waterford, is the only wooden lock remaining on this division of the canals. It is

badly decayed, is too narrow, and should be rebuilt of stone without delay.

The river tow-path wall, for 300 feet south of this lock, is also of wood and in bad order. So large a part of its volume is above water that permanence and economy demand that it should be rebuilt of stone. The lock and retaining wall should be built at the same time as the necessary bailing and draining, for both can be accomplished with the aid of the same coffer dams.

I inclose plans, estimates and specifications for this work. I also inclose a statement of the nature, extent and probable cost of the other special repairs, which appear to me to require immediate attention, excepting the repair of the feeder locks.

The extent of the latter can only be determined after the close of navigation, when the bottoms can be overhauled and examined.

Locks No. 8, No. 11, No. 13 and No. 25 of the Erie canal have defective bottoms, which should be concreted anew, and replanked this winter. The extent and cost of these repairs cannot be determined until the water is withdrawn from the canal.

The east abutment of Spraker's aqueduct should also be rebuilt this winter.

SURVEY OF THE ERIE CANAL.

The survey was begun the 12th of June, 1876, and the field work was completed October 31st, 1876, but we have only recently completed plotting the levels and soundings and developed the results of the survey.

An inspection of the cross-sections discloses the fact that there is no place on this division of the Erie canal where there is not now in the middle of the prism seven feet available depth of water, and very few places where the water section is not of greater area than the standard section provided by the plan of enlargement.

The average depth is more than seven and a-half feet in the center and six and a-half feet at the bottom of the slope. The effect of currents and waves of displacement has been to produce a natural curvature in the bottom, and it is extremely doubtful whether any money can properly be expended on this portion of the Erie canal "for the purpose of securing a uniform depth of seven feet of water therein."

This is true of those portions where the much abused wall-benches remain. In fact, I consider the removal and substitution of steep slope indefensible on engineering grounds, whether regard be had to the economy and durability of the constructions for protecting the banks, or the adaptability of the form of channel section to the purposes of navigation.

The pretense has been that a larger prism was required and was thus

produced, but where the wall-benches remain the water section is more than four times the submerged section of the largest loaded boat, which is deemed sufficient by competent authorities, and, in truth, the removal of the wall-bench has generally resulted in widening the prism at the bottom and narrowing it at the top, without materially altering its sectional area.

These cross-sections, however, indicate that the tow-path embankment has not been uniformly kept up to the standard hight. The extent of it which requires raising to insure the safety of the prism is not very considerable and can readily be raised in the ordinary repair of the canal.

In making this survey of the Erie canal we have, by consecutive measurements and carefully tested levels, accurately determined the position, elevation and lift of the various locks, and the position and dimensions of all its important structures, and have established permanent benches, which are described and recorded for future reference. We have also determined and recorded the most important details of construction and the present condition of all the structures, so that we now have the data for estimating closely the probable cost of their annual maintenance. I have already tabulated all the important structures of the Erie canal upon this division, and computed the quantities of perishable materials they contain, with the following results:

The materials are classified with reference to their comparative durability.

NUMBER OF BRIDGES, EASTERN DIVISION, ERIE CANAL.

Street and road, wrought iron	10	
Street and road, cast iron	32	
Street and road, iron lower chords	24	
Street and road, chords and struts entirely of wood	8	
		74
Change bridges, wrought iron	1	
Change bridges, chords and struts entirely of wood	1	
		2
Farm bridges, wood with iron chords	17	
Farm bridges, entirely of wood	86	
		103
Total number of bridges		179

LOCKS — ERIE CANAL.

NUMBER.	Elevation of lower mitre-sill above T. W.	Elevation of coping above T. W.	Lift.
1	−7.443	16.115	15.159
2	7.716	25.716	9.495
3	17.211	37.471	11.169
4	28.380	48.600	11.380
5	39.760	59 390	10.597
6	50.357	69.357	10.073
7	60.430	79.010	9.931
8	70.361	89.246	10.545
9	80.906	99.406	9.408
10	90.314	109.314	10.362
11	100.676	119.326	9.621
12	110.297	129.387	9.896
13	120.193	139.293	10.345
14	130.548	149.248	10.032
15	140.580	159 380	9.833
16	150.413	169.333	10.045
17	160.458	179.478	10.287
18	170.745	189.785	10.249
19	180.994	198.214	8.441
20	189.435	208.095	10.418
21	199.853	219.573	11.126
22	210.979	231.159	11.609
23	222.588	239.488	8.318
24	230.906	247.766	7.326
25	238.232	255.762	8.581
26	246.813	263.683	8.365
27	255.178	271.608	7.886
28	263.164	280.034	7.723
29	270.887	287.407	7.399
30	278.286	297.656	10.213
31	288.499	303.259	5.867
32	294.366	311.476	8.126
33	302.492	317.262	5.704
34	308.196	325.276	8.483
35	316.679	333.529	7.785
36	324.464	343.244	10.019
37	334.483	353.273	9.898
38	344.381	362.901	8.733
39	353.114	372.944	10.524
40	363.638	380.718	8.524
41	372.162	389.012	8.286
42	380.448	397.118	7.954
43	388.402	404.902	8.069
44	396.471	416.441	10.737
45	407.208	427.338	11.172
1		Lower side-cut, W. Troy, single locks.	
2			
1		Upper side-cut, West Troy, double locks.	
2			
1		Weigh-lock at Albany.	
2		Weigh-lock at West Troy.	

AQUEDUCTS — ERIE CANAL.

Number.	Name.	LOCATION — DISTANCE WEST OF LOCK.	Interior width.	Number of spans.	Total length.
1	Lower Mohawk...	220 chains 52 links W. of lock 18. ..	40 ft. 6 in.	....	17 chs. 23 lks.
2	Upper Mohawk...	6 chains 60 links W. of lock 22. ..	44 ft. 4 in.	....	9 chs. 25 lks.
3	Flat Stone creek..	113 chains 97 links W. of lock 24.....	.....	3	1 ch. 13 lks.
4	Sansai Kill... ...	171 chains 9 links W. of lock 25....	52 ft....	4	1 ch. 55 lks.
5	Schoharie creek...	8 chains 97 links W. of lock 30. ...	40⅛ ft...	14	9 chs. 46 lks.
6	Tokkon creek....	664 chains 91 links W. of lock 30.....	51⅓ ft....	4	1 ch. 53 lks.
7	Leonardson creek.	846 chains 38 links W. of lock 30.....	51 ft....	4	1 ch. 53 lks.
8	Leonardson creek.	934 chains 92 links W. of lock 30.....	50 ft....	3	1 ch. 13 lks.
9	Platt Kill	5 chains 77 links W. of lock 31. ..	50 ft....	5	1 ch. 94 lks.
10	Bewman's creek..	251 chains 97 links W. of lock 31.....	.....	5	1 ch. 94 lks.
11	Otsquago creek...	18 chains 31 links W. of lock 32.....	.....	5	1 ch. 91 lks.
12	Castle creek.....	7 chains 1 link W. of lock 35.....	50⅛ ft....	5	1 ch. 94 lks.
13	Fulmer creek.....	2 chains 72 links W. of lock 43.....	65⅓ ft....	3	1 ch. 12 lks.
14	Aqueduct	129 chains 36 links W. of lock 43.....	51⅓ ft....	2	74 lks.
15	Myers' creek.....	2 chains 74 links W. of lock 45.....	66 ft....	2	74 lks.
16	Ferguson creek...	452 chains 35 links W. of lock 45.....	57⅓ ft....	1	33 lks.

WASTE WEIRS — ERIE CANAL.

Number.	LOCATION — DISTANCE WEST OF LOCK.	No. valves.	Size of valves.	Length of spillway.	Height of crest-|-C. B.
1	308 chs. 30 lks. W. lock 2	4	2⅓ ft.x3 ft	33 ft. (less 10 posts 1 ft.)	6.83
2	19⅓ chs. W. lock 3	10	2 ft.x2⅓ ft..... ..	15 ft.....	7.58
3	7⅓ chs. W. lock 9	5	2 ft. 1 in x2 ft. 8 in..	14 ft. 6 in....	7.59
4	18 chs. 40 lks. W. lock 18	8	.....	28 ft. 6 in....	6.86
5	12 chs. 20 lks. W. lock 20	4	2 ft.x2⅓ ft.....	17 ft.....	5.91
6	368 chs. 46 lks. W. lock 22	4	2 ft.x2⅓ ft.....	12 ft.	6.80
7	163 chs. 84 lks. W. lock 27	3	4 ft. 3 in.x2 ft. 10 in..	12 ft.....	7.41
8	1097 chs. 9 lks. W. lock 30	4	3 ft.x2⅓ ft.....	12 ft.....	7.48
9	3 chs. 56 lks. W. lock 33	2	5 ft.x2⅓ ft.....	10 ft.....	Bot. of opening 4.5xC. B.
10	286 chs. 2 lks. W. lock 35	5	2 ft.x2⅓ ft.....	13 ft. 6 in....	7.58
11	2⅓ chs. W. lock 36	2	5⅓ ft.x2⅓ ft.	11 ft. 6 in....	Bot. of opening 4.92xC. B.
12	16 chs. 52 lks. W. lock 39	4	....	10 ft..... ...	6.73
13	13 chs. 2 lks. W. lock 40	..	.....	.....	.....
14	10 chs. 64 lks. W. lock 41	4	2⅓ ft.x2 ft. 2 in.....	10 ft.....	7.42
15	18 chs. 32 lks. W. lock 42	..	....	....	Filled up — not in use.

CULVERTS — ERIE CANAL.

Number.	Length.	LOCATION — DISTANCE WEST OF LOCK.	Section arch or box.	Waterway.
1	...	31 chains west of lock 1	Stone diving culvert	3 openings.
2	....	60 chains 75 links west of lock 1	Stone arch culvert	4 ft. chord.
3	140	89 chains west of lock 2	Stone arch culvert	
4	....	97 chains 28 links west of lock 2	Stone arch culvert	
5	....	138⅓ chains west of lock 2	Stone arch culvert	
6	....	167 chains west of lock 2	Stone arch culvert	
7	....	189 chains 40 links west of lock 2	Stone double arch culvert	7 ft. chord.
8	....	276 chains 45 links west of lock 2	Stone double arch culvert	
9	....	313 chains 25 links west of lock 2	Stone double arch culvert	About 8 ft. chord.
10	....	Not located west of lock 2	Arch culvert	12 ft. chord.
11	....	398 chains 30 links west of lock 2	Stone diving culvert	
12	....	16 chains west of lock 3	Stone diving culvert	
13	....	Not located west of lock 6	Semi-circle arch	12 ft. chord, 7 ft. bench walls.
14	....	9⅕ chains west of lock 9	Semi-circle arch	8 ft. chord, 2 ft. 3 in. bench walls.
15	....	9 chains west of lock 18	Semi-circle arch	7⅕ ft. chord, 2 ft. bench walls.
16	....	1 chain west of lock 17	Stone arch culvert	4 ft. chord.
17	....	28 chains 65 links west of lock 18	Semi-circle arch	8 ft. chord, bench walls 3 ft.
18	....	187½ chains west of lock 18	Stone diving culvert	
19	....	260 chains 54 links west of lock 18	Semi-circle arch	8 ft. chord, bench walls 5⅕ ft.
20	....	483 chains 55 links west of lock 18	Stone arch culvert	6 ft. chord.
21	....	515 chains 54 links west of lock 18	Stone acrh diving	
22	....	651 chains 95 links west of lock 18	Stone box diving	3 ft. wide, 2 ft. high.
23	....	65 chains 90 links west of lock 19	Stone semi-circle arch	Chord 9 ft., bench walls 5 ft. 6 in.
24	....	157 chains 12 links west of lock 20		
25	....	5 chains 60 links west of lock 22	Stone arch	Chord 28 ft.
26	...	203 chains 86 links west of lock 22	Stone arch	Chord 7 ft. 6 in., 2 ft. rise, B. wall 4 ft.
27	....	277⅕ chains west of lock 22	Stone arch diving	Chord 18 ft., rise 2 ft. 6 in.
28	....	299 chains 70 links west of lock 22	Stone culvert	
29	....	349 chains 95 links west of lock 22	Stone arch	About 8 ft. chord.
30	....	412 chains 25 links west of lock 22	Stone arch	About 7 ft. chord.
31	....	464 chains 50 links west of lock 22	Stone semi-circle arch	12 ft. chord, 2 ft. 6 in. B. walls.
32	....	12 chains west of lock 24	Stone arch	7 ft. chord.
33	....	149 chains 40 links west of lock 24	Stone arch	7 ft. chord, 2⅕ B. walls.
34	...	174 chains 12 links west of lock 24	Stone semi-circle arch	11 ft. chord.
35	....	154 chains 60 links west of lock 25	Stone box	2 ft. 6 in. wide, 2 ft. 10 in. high.
36	....	218 chains 8 links west of lock 25	Stone semi-circle arch drop	4 ft. chord, B. walls 1 ft. 6 in.
37	....	269 chains 90 links west of lock 25	Wooden box culvert	2 ft. 4 in. x 1 ft. 4 in.
38	....	360 chains 70 links west of lock 25	Stone semi-circle arch	4 ft. chord.
39	....	401 chains 20 links west of lock 25	Stone arch drop	10 ft. chord, 2⅕ ft. rise.
40	....	3 chains 13 links west of lock 27	Stone drop (double)	18 ft. chord, 3 ft. rise, B. walls 2 ft. 6 in.
41	....	61 chains 45 links west of lock 27	Stone arch	7 ft. chord, 4⅕ B. walls.
42	....	96 chains 40 links west of lock 27	Stone arch drop culvert	4 ft. chord, 2 ft. B. walls.

43	....	163	chains 84 links west of lock 27.....	Stone arch drop culvert.....	6 ft. chord, 2 ft. 6 in. B. walls.
44	....	207	chains west of lock 27.....	Stone culvert	
45	....	225	chains 17 links west of lock 27.....	Stone arch (4 arches).....	22 ft. chord, 4 ft. rise B. walls 3 ft.
46	....	5	chains 24 links west of lock 28.....	Stone arch drop.....	6 ft. 2 in. chord, 3 ft. 2 in. high.
47	....	85	chains 20 links west of lock 28.....	Stone arch culvert	4 ft. chord, 1 ft. B. walls.
48	....	140	chains west of lock 28.....	Small stone diving culvert	
49	....	71	chains 50 links west of lock 30.....	Stone arch culvert.....	4 ft. chord and 2 ft. high.
50	...	146	chains 20 links west of lock 30.....	Stone double arch.....	10 ft. chord, 3 ft. 4 in. rise B. walls 2 ft.
51	....	170½	chains west of lock 30.....	Stone arch (4 arches).....	22 ft. 3 in. span 4 ft. rise B. walls 4 ft. 6 in.
52	....	282	chains 50 links west of lock 30.....	Stone box diving.....	3 ft. wide.
53	....	336	chains west of lock 30.....	Stone arch drop	4 ft. chord.
54	....	400	chains 25 links west of lock 30.....	Stone arch drop (double).....	2 ft. chord (about).
55	....	427	chains 10 links west of lock 30.....	Stone arch drop.....	4 ft. chord about 2 ft. rise.
56	...	707	chains 40 links west of lock 30.....	Stone semi-circular arch	4 ft. chord, 1½ ft. bench walls.
57	...	807	chains 60 links west of lock 30.....	Stone semi-circular arch drop.....	4 ft. chord, 1½ ft. bench walls.
58	...	1096	chains 55 links west of lock 30.....	Stone box drop	5 ft. wide.
59	....	32	chains 65 links west of lock 31..	Stone arch drop.....	About 8 ft. chord, 2 feet rise.
60	....	224	chains 80 links west of lock 31...	Stone semi-circular arch	4 ft. chord.
61	....	294	chains 36 links west of lock 31.....	Stone drop.....	
62	....	377	chains 70 links west of lock 31.....	Stone drop box and arch.....	17 ft. chord, 6 ft. 3 in. rise.
63	..	78	chains west of lock 32.....	Stone box.....	2 ft. x 2 ft.
64	....	122	chains west of lock 32.....	Stone arch.....	12 ft. chord, 3 ft. rise.
65	....	140	chains west of lock 32.....	Stone drop.....	
66	...	243	chains 40 links west of lock 32.....	Stone arch drop.....	7 ft. chord, 2⅛ ft. rise.
67	....	314	chains 84 links west of lock 32.....	Stone arch culvert	
68	....	29	chains 20 links west of lock 33.....	Stone semi-circular arch diving.....	6 ft. chord, 1 ft. B. walls.
69	...	172	chains 35 links west of lock 33.....	Stone wooden box.....	4 ft. high 2 ft. wide.
70	....	210	chains west of lock 34.....	Diving.....	8 ft. wide (about).
71	....	92	chains west of lock 35.....	Stone.....	
72	....	222	chains 36 links west of lock 35.....	Stone diving culvert	
73	....	158	chains 8 links west of lock 39...	Stone diving culvert	
74	....	199	chains 94 links west of lock 39.....	Stone diving culvert	
75	....	8	chains west of lock 40.....	Stone arch	4 ft. chord (about).
76	....	107	chains 80 links west of lock 40.....	Stone diving culvert	
77	.. .	147	chains 20 links west of lock 40.....	Stone diving culvert	
78	...	7	chains 12 links west of lock 41.....	Stone arch drop (double arch).....	6 feet chord, 1 ft. 6 in. rise B. Walls 2⅛ ft.
79	....	26	chains 75 links west of lock 43.....	Stone box culvert.....	4½ ft. wide, 2 openings.
80	....	77	chains 60 links west of lock 43.....	Stone semi-circular arch	3 ft. chord, 1 ft. B. walls.
81	....	191	chains 10 links west of lock 43.....	Stone semi-circular arch	7 ft. chord, 2 ft. B. walls.
82	....	207	chains 57 links west of lock 43.....	Stone semi-circular arch	8 ft. chord, 2 ft. 9 in. B. walls.
83	....	118	chains 65 links west of lock 45.....	Stone arch..	12 ft. chord, 3 ft. rise 8 ft. B. walls.
84	....	285	chains 70 links west of lock 45.....	Stone box	2 ft. x 2 ft.
85	....	370	chains west of lock 45.....	Stone box	2 ft. 6 in. wide x 2 ft. high.
86	....	397	chains 30 links west of lock 45.....	Stone box	2 ft. 6 in. wide, 2 ft. high.
87	....	468	chains 60 links west of lock 45	Stone semi-circular arch	4 ft. chord, 1½ ft. B. walls.

BRIDGES.

	FT., B. M.
Quantity of timber in floors of street, change and road bridges,	350,419
Quantity of timber in floors of farm bridges	272,685
Quantity of timber in floor joists and sidewalks of all bridges	319,861
Quantity of timber in needle beams of all bridges	129,574
Quantity of timber in trusses of all bridges	510,065

Our statistics of bridges recently repaired have led me to the following conclusions as to the life of these different classes of materials:

Oak in floors for street, change and road bridges	5 years.
Hemlock in floors for farm bridges	6 years.
Pine in joists and sidewalks plank of all bridges	8 years.
Oak in needle beams of all bridges	8 years.
Pine in trusses of all bridges	12 years.

Applying these conclusions to the classified quantities, the annual cost of maintaining these structures would be, making due allowance for removal of old and substitution of new work, and repairs and renewal of iron:

94,015 square feet painting, at 2 cents	$1,880 30
70,084 feet, B. M., oak in floors, at $40	2,803 36
45,447 feet, B. M., hemlock in floors, at $25	1,136 18
39,983 feet, B. M., pine in joists and sidewalks, at $40	1,599 32
16,197 feet, B. M., oak in needle beams, at $75	1,214 78
42,505 feet, B. M., pine in trusses, at $75	3,187 87
	$11,821 81

LOCKS.

	FT, B. M.
Quantity of oak in gates	666,600
Quantity of pine in gates	68,992
Quantity of oak in piers	268,182
Quantity of pine in piers	804,546
Quantity of oak in mitre sills	103,880
Quantity of pine in floors	1,869,200

The life of the different classes of materials are estimated as follows:

Oak in gates	6 years.
Pine in gates	6 years.
Oak in piers	15 years.
Pine in piers	15 years.
Oak in mitre sills	20 years.
Pine in floors	20 years.

The annual cost of maintaining these structures would be, considering the removal of old and substitution of new work, and removal of iron:

111,100 feet, B. M., oak in gates, at $80	$8,888 00
11,500 feet, B. M., pine in gates, at $50	575 00
17,880 feet, B. M., oak in piers, at $50	894 00
53,639 feet, B. M., pine in piers, at $40	2,145 56
5,194 feet, B. M., oak in mitre-sills, at $50	259 70
93,460 feet, B. M., pine floors, at $40	3,738 40
Total	$16,500 66

AQUEDUCTS.

	FT., B. M.
Quantity of oak in sides	464,396
Quantity of pine in sides	158,590
Quantity of oak in bottom	395,849
Quantity of pine in bottom	2,370,275

The life of the different classes of timber are estimated as follows:

Oak in sides	12 years.
Pine in sides	12 years.
Oak in bottom	16 years.
Pine in bottom	16 years.

The annual cost of maintaining these structures would be, considering the removal of old and substitution of new work, and renewal of iron:

38,700 feet, B. M., oak in sides, at $60	$2,322 00
13,216 feet, B. M., pine in sides, at $40	528 64
24,741 feet, B. M., oak in bottom, at $60	1,484 46
148,142 feet, B. M., pine in bottom, at $40	5,925 68
Total	$10,260 78

WASTE WEIRS.

	FT. B. M.
Quantity of pine in floors	25,530
Quantity of oak in bulk-head	23,422
Quantity of pine in bulk-head	2,814

The life of these different classes of materials are estimated as follows:

Pine in floors	15 years.
Oak in bulkhead	12 years.
Pine in bulkhead	12 years.

The annual cost of maintaining these structures would be, considering the removal of old and substitution of new work and renewal of iron:

1,702 feet, B. M., pine in floors at $40	$68 08
1,952 feet, B. M., oak in bulk-head, at $60	117 12
235 feet, B. M., pine in bulk-head, at $40	9 40
Total	$194 60

IMPROVEMENT OF THE CHAMPLAIN CANAL.

The work of our force on this canal has been directed to ascertaining the quantities and probable cost of the work involved in strengthening and raising its banks during the season of navigation, so as to secure a uniform depth of six feet throughout its extent, provided for in act chapter 185 of the Laws of 1876. Carefully prepared estimates, plans and specifications for executing the improvement in this way are already in your possession.

Consecutive measurements and levels have not been undertaken in the survey of this canal, but the dimensions, character and condition of its structures have been noted. The bridges have been tabulated and amounts of timber in their superstructures classified, as on the Erie canal.

BRIDGES ON THE CHAMPLAIN CANAL AND GLENS FALLS FEEDER.

Street and road, wrought iron	9	
Street and road, cast iron	4	
Street and road, wood with iron chord	2	
Street and road, entirely of wood	51	
		66
Farm bridges, wood with iron lower chords	..	
Farm bridges, entirely of wood	85	
		85
Change bridges, entirely of wood		9
Total number of bridges		160

Feet, B. M., oak in floors of street, change and road bridges	192,563
Feet, B. M., hemlock in floors of farm bridges	171,360
Feet, B. M., oak in needle beams	81,610
Feet, B. M., pine in joists	199,605
Feet, B. M., pine in trusses	353,103

Adopting the same periods of durability for these various classes, as in the Erie estimates, we have for the probable annual cost of maintaining these structures:

38,513 feet, B. M., oak in floors, at $40	$1,540 52
28,560 feet, B. M., hemlock, in floors, at $25	714 00
10,201 feet, B. M., oak in needle beams, at $75	765 08
24,951 feet, B. M., pine in joists, at $40	998 04
29,425 feet, B. M., pine in trusses, at $75	2,206 88
61,867 square feet painting, at 2 cents	1,237 34
	$7,461 86

The perishable materials in the other structures of this canal have not yet been computed and classified.

LOCKS OF THE CHAMPLAIN CANAL.

NUMBER.	Elevation of lower mitre-sill above T W.	Elevation of coping above T.W.	Lift.
1	17.345	37.985	11.381
2	28.727	49.336	12.099
3	40.900	51.960	0.0
4	40.900	53.270	0.0
5	40.825	62.025	13.206
6	54.031	75.012	11.412
7	65.444	83.632	9.288
8	74.731	94.706	11.033
9	85.764	102.824	8.484
10	94.248	.....	0.0
11	94.248	112.999	9.944
12	104.148	122.009	9.135
13	113.283	132.398	9.787
14	123.070	141.150	9.098
15	132.168	149.148	8.000
16	132.670	149.574	7.498
17	124.558	141.508	8.112
18	117.443	133.493	7.115
19	115.348	128.350	2.095
20	115.210	128.212	0.138
21	106.210	122.815	9.000
22	97.210	113.815	9.000
23	87.210	103.815	10.000

1	Lock on Waterford side-cut.
2	Lock on Waterford side-cut.
3	Lock on Waterford side-cut.
1	Weigh-lock at Waterford.
.....	Sloop lock at Troy dam.

THE ENGINEERING DEPARTMENT.

The engineering of this division was in charge of E. Sweet, Jr., division engineer, and B. Godwin, resident engineer, during the fiscal year.

The engineering force has been employed in making the surveys, measurements and computations required for the settlement of pending contracts; in completing the survey of the Erie canal and recording its results, provided for by act chapter 425, Laws of 1876; in completing the surveys, maps, plans and estimates for the improvement of the Champlain canal, authorized by act chapter 185, Laws of 1876, and in making surveys, etc., for Canal Appraisers, examinations, estimates and plans for "ordinary repairs" and contemplated structures.

A detailed statement of the expenditures of the department on this division is annexed. It may be summarized as follows:

Expended for "ordinary repairs," October 1st, 1876, to October 1st, 1877	$8,027 89
Expended for Erie survey	1,016 87
Expended for improvement of Champlain, October 1st, 1876, to October 1st, 1877	2,424 50
Expended for extraordinary repairs, October 1st, 1876, to October 1st, 1877	5,085 32
Total	$16,554 58

TABLES

Showing the number and compensation of Engineers employed on the Eastern Division of the New York State canals, together with the incidental expenses from October 1, 1876, to September 30, 1877, inclusive.

ORDINARY REPAIRS ERIE CANAL.

NAME.	Rank.	No. of Days.	Rate.	Amount.	Total.
E. Sweet, Jr	Division Engineer	Salary	$2,400 00	$1,600 00	
E. Sweet, Jr	Division Engineer	Travel		457 98	
B. Godwin	Resident Engineer	Salary	2,000 00	1,333 32	
B. Godwin	Resident Engineer	Travel		213 00	
A. Plinta	Assistant Engineer	78	5 00	390 00	
H. C. Parsons	Leveler	78	4 50	351 00	
J. R. Kaley	Rodman	53	3 50	185 50	
L. C. Wilder	Rodman	12	3 50	42 00	
					$4,572 80
Incidental Expenses.					
Stationery				$143 56	
Fuel				38 00	
Office rent				350 00	
Postage and telegraph				93 69	
Miscellaneous				813 14	
					1,438 39
					$6,011 19

TABLES *showing the number and compensation of Engineers, etc.* — (Continued).

ORDINARY REPAIRS CHAMPLAIN CANAL.

NAME.	Rank.	No. of Days.	Rate.	Amount.	Total.
E. Sweet, Jr.....	Division Engineer	Salary ...	$2,400 00	$800 00	
E. Sweet, Jr.....	Division Engineer	Travel ...	....	276 30	
B. Godwin.....	Resident Engineer	Salary ...	2,000 00	666 68	
B. Godwin.....	Resident Engineer	Travel ...	.....	273 72	
					$2,016 70

TABLES *showing the number and compensation of Engineers, etc.* — (Continued).

ENLARGEMENT, CHAMPLAIN CANAL.

NAME.	Rank.	No. of days.	Rate.	Amount.	Total.
J. L. Dodge	Assistant engineer in charge	78	$6 00	$468 00	
H. Goold	Assistant engineer	78	5 00	390 00	
A. Plinta	Assistant engineer	49½	5 00	247 50	
H. C. Parsons	Leveler	78	4 50	351 00	
A. Plinta	Draughtsman	3	5 00	15 00	
J. R. Kaley	Rodman	142	3 50	497 00	
L. C. Wilder	Rodman	76	3 50	231 00	
T. Daly	Chainman	52	2 50	130 00	
D. W. Harding	Chainman	34	2 50	85 00	
F. J. Harris	Chainman	4	2 50	10 00	
					$2,424 50

TABLES *showing the number and compensation of Engineers, etc.* — (Continued).

EXTRAORDINARY REPAIRS.

NAME.	Rank.	No. of days.	Rate.	Amount.	Total.
J. L. Dodge	Assistant engineer in charge	156	$6 00	$936 00	
J. L. Dodge	Assistant engineer	78	5 00	390 00	
H. Goold	Assistant engineer	234	5 00	1,170 00	
A. Plinta	Assistant engineer	104	5 00	520 00	
H. C. Parsons	Leveler	103	4 50	463 50	
J. R. Kaley	Rodman	79	3 50	276 50	
L. C. Wilder	Rodman	111	3 50	388 50	
T. Daly	Chainman	104	2 50	260 00	
D. W. Harding	Chainman	159	2 50	397 50	
F. J. Harris	Chainman	5	2 50	12 50	
N. B. Ward	Chainman	77	2 50	192 50	
					$5,007 00
Incidental expenses.					
Miscellaneous				$78 32	
					78 32
					$5,085 32

TABLES *showing the number and compensation of Engineers, etc.* — (Continued).

SURVEY ERIE CANAL.

NAME.	Rank.	No. of days.	Rate.	Amount.	Total.
H. T. Beach	Assistant engineer in charge	26	$6 00	$156 00	
A. Plinta	Assistant engineer	26	5 00	130 00	
J. Squires	Leveler	26	4 50	117 00	
H. C. Parsons	Leveler	53	4 50	238 50	
G. W. Carnrick	Rodman	26	3 50	91 00	
W. S. Lasher	Rodman	26	3 50	91 00	
F. G. Fay	Chainman	26	2 50	65 00	
F. J. Harris	Chainman	21	2 50	52 50	
H. C. Thayer	Chainman	26	2 50	65 00	
					$1,006 00
Incidental expenses.					
Miscellaneous				$10 87	
					10 87
					$1,016 87

SUMMARY.

NAME OF CANAL.	Engineering proper.	Incidentals.	Amounts.	Totals.
Ordinary repairs Erie	$4,572 80	$1,438 39	$6,011 19	.....
Ordinary repairs Champlain	2,016 70	.....	2,016 70	$8,027 89
Enlargement Champlain	2,424 50	.....	2,424 50	2,424 50
Extraordinary repairs	5,007 00	78 32	5,085 32	5,085 32
Survey Erie	1,006 00	10 87	1,016 87	1,016 87
				$16,554 58

SPECIAL REPAIRS, CHAMPLAIN CANAL.

Powers' Culvert, arch, 5 feet radius.

100 cubic yards earth excavation, at 25 cents	$25 00
750 cubic yards embankment, at 25 cents	187 50
50 cubic yards excavation, masonry, at $1	50 00
200 cubic yards new stone delivered, at $4.50	900 00
34 cubic yards arch masonry laid, at $6	204 00
170 cubic yards wing wall laid, at $4	680 00
Contingencies, 15 per cent	306 97
Total	$2,353 47

Raising Flynn's Lock, 18 inches.

70 cubic yards new lock masonry, at $12	$840 00
45 cubic yards coping taken up and relaid, at $3	135 00
Contingencies, 15 per cent	97 50
Total	$1,072 50

Culvert at Mechanicville, 2 arches, 8 feet radius.

1,500 cubic yards earth excavation, at 25 cents	$375 00
1,500 cubic yards embankment, at 25 cents	375 00
300 cubic yards excavation, old masonry, at $1	300 00
200 cubic yards new stone delivered, at $4.50	900 00
125 cubic yards arch masonry laid, at $4	500 00
250 cubic yards wing wall masonry laid, at $2.50	625 00
12,000 feet, B. M., timber, at $30	360 00
Contingencies, 15 per cent	515 25
Total	$3,950 25

Waste-weir at Stillwater.

500 cubic yards earth excavation, at 25 cents	$165 00
200 cubic yards embankment, at 30 cents	60 00
135 cubic yards masonry excavation, at $1	135 00
30 cubic yards stone delivered, at $4.50	135 00
140 cubic yards masonry laid, at $3	420 00
7,000 feet, B. M., timber, at $35	245 00
Contingencies, 15 per cent	174 00
Total	$1,334 00

Waste-weir above Durkee's Bridge.

50 cubic yards masonry relaid, at $4.50	$225 00
110 cubic yards earth excavation, at 25 cents	27 50
110 cubic yards embankment, at 25 cents	27 50
10 cubic yards stone, at $4.50	45 00
500 feet, B. M., timber, at $30	15 00
Contingencies, 15 per cent	51 00
Total	$391 00

Culvert near Bell's Bridge.

30 cubic yards arch masonry, at $6	$180 00
50 cubic yards wing walls, at $4.50	225 00
25 cubic yards masonry excavation, at $1	25 00
50 cubic yards earth, at 25 cents	12 50
150 cubic yards embankment, at 25 cents	37 50
50 cubic yards stone, at $4.50	225 00
Contingencies, 15 per cent	105 75
Total	$810 75

Culvert above School-house Bridge.

25 cubic yards arch masonry, at $6	$150 00
30 cubic yards wing walls at $4.50	135 00
25 cubic yards masonry excavation, at $1	25 00
25 cubic yards earth, at 25 cents	6 25
50 cubic yards embankment, at 25 cents	12 50
30 cubic yards stone, at $4.50	135 00
Contingencies, 15 per cent	69 55
Total	$533 30

Culvert below School-house Bridge.

25 cubic yards arch masonry, at $6	$150 00
30 cubic yards wing walls, at $4.50	135 00
25 cubic yards masonry excavation, at $1	25 00
25 cubic yards earth, at 25 cents	6 25
50 cubic yards embankment, at 25 cents	12 50
30 cubic yards stone, at $4.50	135 00
Contingencies, 15 per cent	69 55
Total	$533 30

Waste-weir near Crocker's Bridge.

15 cubic yards new masonry, at $8	$120 00
10 cubic yards coping relaid, at $3	30 00
10 cubic yards excavation, at 25 cents	2 50
10 cubic yards embankment, at 25 cents	2 50
250 feet, B. M., timber, at $30	7 50
Contingencies, 15 per cent	24 37
Total	$186 87

Culvert near Fort Miller Lock.

25 cubic yards arch masonry, at $6	$150 00
30 cubic yards wing walls, at $4.50	135 00
25 cubic yards masonry excavation, at $1	25 00
25 cubic yards earth, at 25 cents	6 25
50 cubic yards earth embankment, 25 cents	12 50
30 cubic yards stone, at $4.50	135 00
Contingencies, 15 per cent	69 75
Total	$533 50

Waste-weir and Aqueduct near Fort Miller.

150 cubic yards masonry relaid, at $4.50	$675 00
250 cubic yards earth excavation, at 25 cents	62 50
250 cubic yards earth embankment, at 25 cents	62 50
30 cubic yards stone, at $4.50	135 00
1,500 feet, B. M., timber, at $30	45 00
Contingencies, 15 per cent	147 00
Total	$1,127 00

Waste-weir near Bassett's Lock.

50 cubic yards masonry relaid, at $4.50	$225 00
110 cubic yards earth excavation, at 25 cents	27 50
110 cubic yards embankment, at 25 cents	27 50
10 cubic yards stone, $4.50	45 00
500 feet, B. M., timber, at $30	15 00
Contingencies, 15 per cent	51 00
Total	$391 00

Enlarging Waste-weir at Bemis Heights.

750 cubic yards earth excavation, at 25 cents	$187 50
300 cubic yards rock excavation, at $1.25	375 00
75 cubic yards old masonry, at $1	75 00
100 cubic yards embankment, at 25 cents	25 00
50 yards puddling, at 50 cents	25 00
100 cubic yards dimension stone, at $4.50	450 00
160 cubic yards masonry laid, at $4	640 00
40 cubic yards sand, at $1	40 00
80 barrels cement, at $1.10	88 00
1,000 feet, B. M., oak, at 50 cents	50 00
5,000 feet, B. M., pine, at 35 cents	175 00
	$2,130 50
Add ten per cent for contingencies	213 05
Total	$2,343 55

Waste-weir at Hewitts.

100 cubic yards masonry relaid, at $4.50	$450 00
100 cubic yards excavation and embankment, at 50 cents	50 00
20 cubic yards stone, at $5	100 00
1,500 feet, B. M., timber, horse-walk, at $30	45 00
Contingencies, 15 per cent	96 75
Total	$741 75

SPECIAL REPAIRS.

Name of Structure.	Amount.
Power's culvert	$2,353 47
Raising Flynn's lock	1,072 50
Culvert at Mechanicville	3,950 25
Waste-weir at Stillwater	1,334 00
Waste-weir above Durkee's bridge	391 00
Culvert near Bell's bridge	810 75
Culvert above School-house bridge	533 30
Culvert below School-house bridge	533 30
Waste-weir near Crocker's bridge	186 87
Culvert near Fort Miller lock	533 30
Waste-weir and aqueduct near Fort Miller	1,127 00
Waste-weir near Bassett's lock	391 00
Waste-weir at Hewitt's	741 75
Waste-weir at Bemis Heights	2,343 55
Total	$16,302 04

MIDDLE DIVISION.

ANNUAL REPORT OF CHARLES A. SWEET, DIVISION ENGINEER, FOR THE FISCAL YEAR ENDING SEPTEMBER 30, 1877.

DIVISION ENGINEER'S OFFICE,
SYRACUSE, *October* 1, 1877.

Hon. JOHN D. VAN BUREN, Jr., *State Engineer and Surveyor:*

SIR. — I have the honor to present herewith my annual report upon the middle division of the New York State canals, for the fiscal year ending September 30, 1877.

Pursuant to a resolution of the Canal Board, adopted January 3, 1877, the Chemung and Crooked Lake canals were transferred from the middle to the western division.

The lengths of the several navigable canals, river improvements and feeders are now as follows:

Title.		Miles.
Erie canal, from east line of Oneida county to east line of Wayne county		97.02
Limestone feeder, Erie canal to Fayetteville	0.80	
Butternut feeder, Erie canal to Dunlap's mills	1.55	
Camillus feeder, Erie canal to Camillus	1.00	
		3.35
Oneida Lake canal, Durhamville to Oneida lake		5.00
Oswego canal, Syracuse to Oswego		38.00
Cayuga and Seneca canal, Montezuma to Cayuga and Seneca lakes		22.77
Chenango canal, Utica to Binghamton		97.00
Ithaca inlet, Cayuga lake to Ithaca		2.00
Baldwinsville canal, improvements to Jack's Reefs		12.50
Seneca River towing-path, Baldwinsville to Mud lock		5.75
Oneida River improvement, Oswego canal to Oneida lake		20.00
Black River Canal		35.33
Black River feeder and pond, above dam		12.09
Delta feeder		1.38
Black River improvement		42.50
Total miles		394.69

The canals upon this division are supplied with water from the following named sources:

ERIE CANAL.	Acres.	Average depth in feet.	Cubic feet per minute.
Rome level.			
Mohawk and Black river, at Rome	.....	.....	11,766
Black River canal	.....	.....	1,234
Oriskany creek, including Chenango Canal reservoirs	.....	.....	6,000
Oneida Creek feeder	.....	.....	1,000
Cowasselon Creek feeder	.....	.....	200
Limestone Creek feeder	.....	.....	500
Butternut Creek feeder	.....	.....	500
Cazenovia Lake reservoir (for 100 days)	1,778	4.50	3,115
Erieville reservoir (for 100 days)	340	21.50	2,526
De Ruyter reservoir (for 100 days)	626	18.50	3,891
Jamesville reservoir (for 60 days)	252	16.40	2,000
			32,732
Jordan level.			
Nile Mile Creek feeder	.....	.....	800
Carpenter Brook feeder	.....	.....	200
Skaneateles Lake reservoir	8,320	7.00	8,776
Otisco Lake reservoir	2,200	10.00	5,146
			14,922
Port Byron and Montezuma levels.			
Putnam Brook feeder	.....	.....	200
Owasco Creek feeder	.....	.....	4,033
Lake Erie	.....	.....	4,000
			8,233
OSWEGO CANAL.			
Seneca river	.....	.....	54,000
Oneida river	.....	.....	20,000
Erie canal	.....	.....	10,000
			84,000

CAYUGA AND SENECA CANAL.	Acres.	Average depth in feet.	Cubic feet per minute.
Seneca lake	.....	.....	18,000
Erie canal	.....	.....	4,000
			22,000
BLACK RIVER CANAL.			
Woodhull Lake reservoir	1,118	18.00	6,087
North Branch reservoir	277	28.00	2,346
South Branch reservoir	372	26.00	2,926
Sand Lake reservoir	306	15.00	1,388
Mohawk river at Delta	.....	.....	.....
Natural flow of Black river through feeder at Boonville	.....	.....	2,373
			15,120

The water furnished by the last-named reservoirs is drawn only in the very dry season, and passed down through the natural channel of Black river and Woodhull, about twenty miles each, to the pond above the dam at the head of Black River feeder, and conveyed to the summit level of the Black River canal, at Boonville.

From this point the canal is supplied both ways, and the surplus, over that required for the canal north to Lyon's Falls, a distance of ten miles, and south to Rome, distant twenty-five miles, is discharged by a waste-weir into the Lansing Kill, at the south end of the summit, thence into the Mohawk river, and from it into the Erie canal, by the feeder at Rome.

ENGINEER DEPARTMENT.

This division has been in charge of Charles A. Sweet, as division engineer, and Denison Richmond as resident engineer.

The total expenditures for engineering on both ordinary and extraordinary repairs for the last fiscal year, as summarized from Table No. 1, hereto annexed, are as follows:

CANALS.	Ordinary repairs.	Extraordinary repairs.	Total.
Survey of Erie canal	.....	$2,401 61	$2,401 61
Erie canal	$6,087 61	294 00	6,381 61
Oswego canal	1,026 58	320 00	1,346 58
Oneida Lake canal	909 22	2,020 50	2,929 72
Black River canal	430 58	.....	430 58
Cayuga and Seneca canal	304 46	.....	304 46
Chenango canal	59 90	.....	59 90
Totals	$8,818 35	$5,036 11	$13,854 46
From the above total amount there should be deducted:			
Survey of Erie canal (paid from special fund)		$2,401 61	
Survey for complete maps of Oneida Lake canal for appraisers		1,161 00	
			3,562 61
Total engineering proper			$10,291 85

The total amount of work done under the supervision of the engineer department, on both ordinary and extraordinary repairs, for the last fiscal year, as compiled from Tables 2 and 3, is as follows :

CANALS.	Ordinary repairs.	Extraordinary repairs.	Totals.
Erie	$45,396 79	$7,111 80	$52,508 59
Oswego	17,863 37	15,235 05	33,098 42
Cayuga and Seneca	6,198 41	.....	6,198 41
Oneida Lake	.....	17,813 86	17,813 86
Black River	14,384 05	.....	14,384 05
Total	$83,842 62	$40,160 71	$124,003 33

ERIE CANAL.

Extraordinary Repairs.

The total amount of work done under this head for the last fiscal year is $7,111.80, viz.:

For pipe sewers under the canal at Utica	$5,539 85
For materials to rebuild feeder dams	1,571 95
Total	$7,111 80

An appropriation of $6,000 was made by act chapter 425, Laws of 1876, for the construction of two forty-eight inch cast-iron pipe sewers, under the Erie canal, one at First street and one at State street, in the city of Utica; said sewers to be built under the direction of the State Engineer and the commissioner in charge.

Maps, plans, estimated costs and specifications were submitted to, and the same adopted by, the Canal Board January 3, 1877, and the work has been fully and satisfactorily completed at a cost of $5,539.85. Following is a detailed statement of expenditures:

Quantities.	ITEMS.	Price.	Amounts.	Totals.
	Materials.			
65 1115-2240	Tons cast-iron pipe	$34 10	$2,233 47	
2,045	Lbs. lead	06¾	138 04	
.....	Cartage on pipe and lead	.....	59 00	
127.57	Cubic yards vertical wall, stone	1 68	214 88	
82	Barrels hydraulic lime	1 12½	92 25	
48	Loads sand	1 25	60 00	
92	Lbs. manilla rope	15	13 80	
.....	Hardware	.....	49 35	
.....	Lumber	.....	110 78	
.....	Potters clay and coal	.....	10 04	
1	Clip for pipe joints, including express charges	.....	20 45	
.....	Derrick, furnace, kettles, etc	.....	75 00	
.....	Expenses for transporting same	.....	20 06	
.....	Blacksmithing	.....	87 11	
	Total materials	.....	$3,184 23	$3,184 23
	Labor.			
25	Days foreman in charge	$5 00	125 00	
24	Days foreman	3 50	84 00	
10	Days foreman carpenters	3 00	30 00	
69½	Days foreman	2 00	139 00	
26½	Days masons	2 50	66 25	
7½	Days carpenters	2 00	15 00	
23	Days team work	4 00	92 00	
1,426½	Days common labor	1 25	1,783 12	
34	Days water boy	62½	21 25	
	Total labor	.....	$2,355 62	2,355 62
	Total materials and labor	.....	.....	$5,539 85

Following are the actual quantities of work done and materials furnished for the above mentioned work. The prices are assumed, to get the total cost corresponding with the statement of expenditures:

Quantities.	ITEMS.	Price.	Amount.
2.	Bailing and draining	.....	$357 09
2,015.16	Cub. yds. earth excavation.....	$0 30	604 55
185.99	Cub. yds. rock excavation	1 00	185 99
86.96	Cub. yds. wall excavation	75	65 22
1,938.53	Cub. yds. embankment.....	15	290 78
1,539.92	Cub. yds. puddling	10	153 99
189.57	Cub. yds. vertical wall in cement..	4 00	758 28
1,834.	Ft., B. M., oak.....	40 00	73 36
196.	Ft., B. M., pine	40 00	7 84
7,410.	Ft., B. M., hemlock.....	16 00	118 56
1,092.	Ft., B. M., hemlock, replaced	2 00	2 18
146,715.	Lbs. cast iron pipe	01¾	2,567 51
2,045.	Lbs. lead	10	204 50
	Engineering	.....	150 00
	Total cost.....	.....	$5,539 85

The sum of $7,400 was set apart by the Canal Board, September 5, 1876, from the general appropriation of $135,000, under act chapter 425, Laws of 1876, for the reconstruction, of wood, of some of the dams and bulk-heads to the feeders.

Following is a detailed statement, showing progress of work to date, which was done in the same manner as described in the work mentioned above:

ITEMS.	Measure.	Oneida Creek Dam.			Limestone Creek Dam.			Skaneateles Creek Dam.			Totals.
		Quantities.	Price.	Amount.	Quantities.	Price.	Amount.	Quantities.	Price.	Amount.	
White oak	Ft. B. M.	15,350	$34 00	$521 90	....	.....	.....	1,248	$34 00	$42 43	$564 33
White pine	Ft. B. M.	43,531	18 00	783 56	.....	.....	.....	4,620	18 00	83 16	866 72
Hemlock	Ft. B. M.	10,064	14 00	140 90	.....	.....	.....	.....	... ..	.....	140 90
Totals	.....	....	.....	$1,446 36	.....	.....	.....	....	.....	$125 59	$1,571 95

The materials, as shown here, were delivered at the respective sites in December last, and the work should have been fully completed during the lowest stage of water last winter. It is hoped that before the opening of navigation next year these structures will be entirely renewed, as contemplated.

Reference is made to table No. 2, hereto annexed, for amount remaining to be done.

The description of these feeders is as follows:

ONEIDA CREEK FEEDER.

The dam and bulk-head are located on the Oneida creek, about two miles south of the Erie canal, and the water is brought into the Rome level at Durhamville, 26.15 miles east of lock 47. The supply of water from this source is, theoretically, 1,000 cubic feet per minute for 100 days, from a drainage basin of about 25,000 acres.

LIMESTONE CREEK FEEDER.

The stream from which this feeder takes its waters is the natural outlet of DeRuyter reservoir, which is located about twenty-five miles south of the canal, in the south-west corner of Madison county. The feeder dam is located one mile south of the canal, at Fayetteville, and the water is brought into the Rome level 6.53 miles east of lock 47. The natural flow of the stream is 500 cubic feet of water per minute, and the additional supply from DeRuyter reservoir is 3,891 cubic feet per minute for 100 days. The feeder is navigable for large boats, and considerable lime and plaster are shipped from it to all points on the canal.

SKANEATELES CREEK FEEDER

Is located at Jordan and is one of the principal feeders to that level, the summit of the Erie canal on this division, west of Syracuse. The structure to be rebuilt is eight chains south of the canal. The supply of water from this source is 8,776 cubic feet per minute for 100 days, and is derived from Skaneateles lake (ten miles south of the canal), which has an area of 8,320 acres and a drainage basin of 90,000 acres.

ORDINARY REPAIRS.

The repairs for the fiscal year have been made with about the usual care and ability, and, with an occasional exception, no perceptible difference in expenditures.

The plans, with bills of materials of the structures rebuilt, have been furnished as usual by this department to the superintendents, and general direction given to other repairs that required professional services. Estimates in detail have been made for the spring repairs and copies of

the same submitted to you, the Canal Commissioner and to the respective superintendents for their information and guidance in expenditures.

Repairs to the following named bridges have been made, which were recommended in my last report, viz.:

Rewooding and inserting iron needle beams in Grape street bridge, Syracuse	$879 81
Rebuilding St. John's farm bridge (Weedsport)	298 72
Rebuilding Young's farm bridge (Weedsport)	291 09
Rewooding and inserting iron needle beams in Utica street bridge, Port Byron	619 73

Camillus aqueduct, seven miles west of Syracuse on the Jordan level, was entirely rewooded last spring at an expense of $5,495.43.

Seneca River aqueduct, on the Montezuma level, was repaired at the same time to the extent of $951.66. Other repairs have been made which are more fully shown in table No. 3, hereto annexed.

SPECIAL REPAIRS RECOMMENDED TO BE MADE.

Completing approaches to Pratt street bridge in Utica	$5,000 00
Retrunking Whitall's culvert, two miles east of Rome	1,400 00
Rebuilding of iron the upper wooden bridge at Durhamville	2,000 00
Rewooding Herrick's iron chord farm bridge, near Canastota	320 00
Two new tumble-gates for locks 47 and 48	500 00
Rebuilding flume, on plan of cast iron pipe three feet in diameter, from waste weir at Barker's mill (Syracuse level)	3,500 00
Rewooding Clinton street bridge, Syracuse	450 00
Repairs to Madison county reservoirs	20,000 00
Dam and bulkhead, and enlarging prism of Butternut Creek feeder	3,000 00
Total	$37,120 00

The description of the special repairs above noted is as follows:

Pratt Street bridge, in the city of Utica, is composed of a Howe wooden superstructure, with iron chords, supported by stone abutments. Clear span 116 feet, and one roadway nineteen feet. The west approach was nearly completed, and but a little of the east approach made; consequently, in its present condition, it is of no use or benefit to any one. In the estimate for the completion of this work there is included an additional span of fifty-four feet of the Whipple wooden truss over the

street, running parallel to and adjoining the towing path of the canal on the east side, and the completion of the approaches.

Estimated cost, $5,000.

Whitall culvert is located about two miles east of Rome, and drains a large area on the south side of the canal, into the Mohawk river. It is a wooden trunk, of two openings, and with masonry heads. That part of the structure between the front angles of the two banks of the canal has become decayed, and has given much trouble at every spring freshet, when the canal is empty, by the pressure of water in the stream, forcing off the covering timbers. To remedy this, there should be longitudinal binders of white oak, 6 x 8, on top of the covering, over each row of the side timbers, and secured to the foundation timbers by one and one-half inch anchor bolts, with heads and nuts at every nine feet in length.

Estimated cost, $1,400.

The upper road-bridge in Durhamville is an old wooden superstructure, hardly safe for the heavy loads passing over it. It has a clear span of seventy-two feet, roadway of seventeen feet, and two sidewalks of five feet each. I recommend a Whipple iron arch truss.

Estimated cost, $2,000.

The farm bridge, known as "Herrick's bridge," located about two miles west of Canastota, has a Whipple wooden superstructure, with iron chords. The timber has become decayed, and should be renewed.

The estimated cost is $320.

The Madison county reservoirs are located at the summit level of the Chenango canal, and their waters are brought into that canal near Hamilton, and diverted into Oriskany creek at the north end of that level, through Sollsville aqueduct; thence into the Rome level of the Erie canal, through the feeder at Oriskany, furnishing, approximately, 2,500 cubic feet of water per minute for 100 days, in addition to the natural flow of that stream of 3,500 cubic feet per minute.

The detailed estimate and plans for these repairs have been submitted for your consideration.

The estimated costs are as follows:

Eaton Brook reservoir, overfall and paved waste.....	$6,000 00
Bradley Brook reservoir, overfall and paved waste.....	6,500 00
Madison Brook reservoir, protecting inner slope	2,000 00
Luland's Pond reservoir, protecting structure at dam.....	100 00
Rebuilding dams and bulk-heads of main feeders, and cleaning out prisms	3,000 00
Engineering and contingencies	2,400 00
Total.....	$20,000 00

The structure known as Barker's waste-weir is located upon the Syracuse level, and was built for the purpose of discharging the surplus water received through Lodi locks, from the Rome level, and through lock 50, from the Jordan level. It has a spillway of 101 feet in length, and is carried up from canal bottom to a hight of three inches below the established water surface. The flow over the weir varies from three to twelve inches in depth, and furnishes a valuable power for milling purposes, the State receiving an annual rent therefor. A wall, of the same length as the spillway, and seven feet in width, receives the overflow, and the water is then discharged into two wooden flumes, with separate bulkheads attached, thence conducted to the center of the culvert spanning Onondaga creek, a distance of 180 feet. The north flume is the property of the State, and occupies the space between the north wall of the mill and the private flume adjoining. To prevent the danger of undermining the walls of the culvert, under the canal, at the point of discharge, it has been necessary to carry the trunk upon a wooden trestle for a distance of about sixty feet. The greatest head at the well is seven and one-half feet, and grade of bottom 0.017 per foot, with a drop of six feet near the upper end. The trunk has become so decayed in places as to need extensive repairs, which, owing to complication of construction, in passing through the mill, cannot be satisfactorily done.

Two estimates for your consideration have been made for rebuilding this work, viz.: One with a cast-iron pipe three feet in diameter, at a cost of $3,500, and the other to rebuild it on the present plan, at a cost of $2,500. I recommend the plan of a cast-iron pipe as a permanent and suitable conduit. It would avoid all subsequent expenses for repairs or rebuilding, while if replaced on the present plan, repairs would soon have to be made, followed by an entire reconstruction in a few years.

IMPROVEMENTS TO BUTTERNUT CREEK FEEDER.

This work is for the purpose of making available the waters from Butternut Creek reservoir at Jamesville. The natural flow of this stream is 500 cubic feet per minute, which is about the capacity of the old mill-race above the navigable feeder at Dunlap's Mills. Now, that this reservoir is completed and calculated to furnish 2,000 cubic feet per minute in addition, some provision ought to be made for receiving this quantity into the Erie canal. The estimated cost to build a dam and bulkhead, and to enlarge the prism of the feeder capable of carrying 2,500 cubic feet per minute, is $3,000.

A break occurred at midnight on Saturday the 2d of June, in the berme bank on the Jordan level, about one-half mile west of Lock 50, which interrupted navigation about twenty-two hours. The bank at this point is about four feet above the natural surface, which has a gradual fall to

a culvert under the canal ten chains east. The water flooded a small area of meadow land on the berme or south side, and after passing through the culvert covered about five acres of corn ground. The damages were, however, small, and, perhaps, will not be noticed by any claims. The cause of the break was owing to excess of water in the canal, let down from Camillus feeder from Otisco Lake reservoir, and overflowing the bank. As this is the Summit level, and almost entirely dependent in the dry season on artificial reservoirs, it seems that greater care should be taken in preserving the water supply for canal purposes.

OSWEGO CANAL.

Extraordinary repairs.

In compliance with your instructions the work of protecting the Oswego river dams by sloping aprons has been done, and, as far as completed, has given good satisfaction toward the safety of these structures. The amount set apart from the general appropriation of $135,000, under act chapter 425, Laws of 1876, was $21,000 for the four dams. The expense of the work done, as contemplated, was $15,235.05, or $5,764.95 less than the original estimate. As this unexpended balance will revert to the treasury before any further work of this kind can be done, I recommend that an appropriation of $20,000 be made by this Legislature for the completion of these aprons.

Following is a detailed statement of expenditures for this work, done by the superintendent of section No. 2, under the direction of the State Engineer and commissioner in charge:

DETAILED final statement of expenditures for the construction of sloping aprons to Oswego river dams, as authorized by act chapter 425, *Laws of* 1876, *and pursuant to a resolution of the Canal Board, adopted September* 5, 1876, *part of appropriation* $135,000.

ITEMS.	Measure.	Phœnix Dam.			Fulton Dam.			Van Buren Dam.			Minetto Dam.			Totals.
		Quantities.	Price.	Amounts.	Quantities.	Price.	Amounts.	Quantities.	Price.	Amounts.	Quantities.	Price.	Amounts.	
White pine	Feet, B. M.	40,847	$20 00	$816 94	56,506	$20 00	$1,130 12	86,252	$20 00	$1,725 04	32,791	$20 00	$655 82	$4,327 92
White oak	Feet, B. M.	.....	.....	.....	104	40 00	4 16	.....	.....	.....	.....	.....	.....	4 16
Chestnut	Feet, B. M.	.....	.....	.....	7,398	20 00	147 96	.....	.....	.....	.....	.....	.....	147 96
Elm	Feet, B. M.	2,833	18 00	50 99	11,797	18 00	212 36	9,628	18 00	173 30	4,289	18 00	77 20	513 85
Hemlock	Feet, B. M.	13,448	10 00	134 48	50,992	10 00	509 92	36,155	10 00	361 55	15,359	10 00	153 59	1,159 54
Hemlock	Feet, B. M.	1,300	6 00	7 80	.....	.....	.....	.....	.....	.....	.....	.....	.....	7 80
Stone in work	Cords	51.66	3 00	154 98	195	3 00	585 00	158.77	3 00	476 31	61.56	4 00	246 32	1,462 61
Wrought iron	Pounds	4,984	02.95	147 03	7,508	02.95	221 49	11,300	02.95	333 35	3,934	02.95	116 05	817 92
Wrought iron	Pounds	.....	.....	.....	601	03.	18 03	.....	.....	.....	.....	.....	.....	18 03
Hardware and tools	.....	.....	.....	68 78	.....	.....	90 87	.....	.....	104 17	.....	.....	40 39	304 21
Blacksmithing	.....	.....	.....	38 69	.....	.....	87 36	.....	.....	48 62	.....	.....	3 00	177 67
Use of flat boat	Days	26	2 00	52 00	.....	.....	.....	55	2 00	110 00	20½	2 00	41 00	203 00
Team towing boats	Days	12¾	1 80	22 95	42	1 80	75 60	31¼	1 80	56 25	5	1 80	9 00	163 80
Use of ground, b'ldgs & dock	.....	.....	.....	15 00	.....	.....	.....	.....	.....	15 00	.....	.....	42 00	72 00
Miscellaneous	.....	.....	.....	28 23	.....	.....	44 77	.....	.....	47 00	.....	.....	63	120 63
Materials on hand	.....	.....	.....	84 98	.....	.....	98 86	.....	.....	9 28	.....	.....	24 13	217 25
Special foreman	Days	.....	.....	.....	24	3 70	88 80	24	3 70	88 80	20	3 70	74 00	251 60
Foreman of carpenters	Days	18¾	3 00	56 25	52⅛	3 00	157 50	43	3 00	129 00	22	3 00	66 00	408 75
Foreman of common labor	Days	53¼	2 40	127 80	99	2 40	237 60	93¼	2 40	223 80	22	2 40	57 60	646 80
Carpenters	Days	133¼	2 00	266 50	134	2 00	268 00	203¾	2 00	407 50	74⅛	2 00	149 00	1,091 00
Carpenters (water-work)	Days	.....	.....	.....	.....	.....	78 25	.....	.....	.....	.....	.....	20 00	98 25
Stone cutters	Days	.....	.....	.....	16½	2 00	33 00	20¼	2 00	41 00	7	2 00	14 00	88 00
Common labor	Days	171	1 40	237 40	752⅝	1 40	1,053 85	807¾	1 40	1,130 85	243¾	1 40	341 25	2,765 35
Teams	Days	2¼	3 20	7 20	9⅛	3 20	30 40	9	3 20	28 80	7	3 20	22 40	88 80
Water boys	Days	.....	.....	.....	.....	.....	.....	.....	.....	.....	15¾	1 00	15 75	15 75
Engineer's inspector	Days	8	3 00	24 00	.....	.....	.....	16	2 40	38 40	.....	.....	.....	62 40
Totals				$2,344 00			$5,173 90			$5,548 02			$2,169 13	$15,235 05

Ordinary Repairs.

The ordinary repairs the last fiscal year placed this canal in better condition than it has been for many years past. Six bridges have been rebuilt at a total cost of $3,836.51, the plans for which, together, with other repairs, which are fully shown in table No. 3, were furnished by this department.

The lower gate to lock No. 11, or "Orchard lock," gave out about nine A. M. June fifth, which caused a detention to navigation of fifty-five hours. A stone became wedged between the gate and miter-sill while filling the lock, and when the pressure became sufficiently strong the gate was forced up, breaking the collar and passed over the sill. The repairs consisted of one heel post, one toe post and some work on the irons, amounting to not more than fifty dollars outside of the ordinary State labor. The long detention was owing to not having on hand duplicate gates for some of these locks. There are many of them of the same lift, and if there were but a few on hand they could be used to an advantage.

The wooden flume, feeding the north side cut at Salina from the Syracuse level, has become decayed and should be built throughout. The estimated cost is $800.

The waste weir on the Liverpool level, near lock No. 4, has become unsafe from long use and should be rebuilt. Estimated cost $1,000.

The south side-cuts at Salina, from which considerable salt is shipped, require quite extensive repairs. No work of any consequence has been done on them for several years, and the docking has fallen in, in many places. The expense for placing them in good condition is estimated at $5,500.

The sluices or inlets on the river level, between locks 4 and 3, river point, will need rebuilding. There are six in number, and will average in cost $100, or a total amount of $600.

The three first locks at Salina should have full sets of gates, as the present ones have become unsafe, and liable to fail at any time, which would interrupt navigation seriously before they could be replaced by new ones. The cost of materials and framing same is estimated at $1,600.

In the enlargement of this canal it seems to have been necessary to widen the tow-path in several places, by driving piles at the foot of the slope wall, and planking over from them to the original front angle. At two of these places the timber work has given out and let the original slope of the bank into the canal. One is at upper landing, and the other at Fulton. The length of each is 200 feet. I recommend that a vertical wall be substituted in place of rebuilding on the old plan.

The cost will not exceed three dollars and fifty cents per foot, or a total of $1,400.

The total estimated cost for special repairs on this canal, as described above, is $10,900.

CAYUGA AND SENECA CANAL.

The expenditures for ordinary repairs this year are less than for any year since the enlargement, and yet the canal is in better condition.

New lock-gates have been made, and quite extensive repairs done to the bridges and other structures.

An appropriation of $5,000 was made by act chapter 193, Laws of 1876, "for removing bars and dredging the channel of Cayuga inlet at Ithaca, to be under the direction of the Canal Commissioner in charge of the middle division." The surveys were made for this work, together with repairs to the long pier in the harbor, and protection to the banks of Fall creek, and the maps, plans, estimated costs, and specifications, were submitted for your consideration. The estimated costs are as follows:

Removing bars from channel proper	$865 00
Repairing pier in harbor	3,055 00
Guard bank on Fall brook	1,080 00
Total	$5,000 00

No work has been done, the reason of which I have not been advised.

ONEIDA LAKE CANAL.

This canal extends from the Erie canal, at Durhamville, to South Bay, Oneida lake, a distance of five and three-tenths miles. It has a total fall from the Erie canal of sixty-two feet, which is overcome by six locks, four of ten feet each, and two of eleven feet each.

The construction of this canal was authorized by act chapter 934, Laws of 1867, and work was commenced the following year. The total amount expended under contract toward its completion was $386,673.05, leaving to complete at the prices under the last contract the sum of $29,700. Work was suspended in June, 1875, and the contract settled. Chapter 301, Laws of 1877, re-appropriated the unexpended balances of former appropriations, amounting to $48,231.20, for the completion, "provided the Canal Board recommended the same."

Plans and estimates for completing the canal with five feet depth of water, without slope-walls, were adopted by the Canal Board, April 10, 1877, and directed that the work be executed by the superintendent, under the joint supervision of the State Engineer and Surveyor and Canal Commissioner.

Following is the summary of the estimate submitted and approved:

Bailing and draining	$100 00
Grubbing and clearing	50 00

Constructing swing bridge at Junction with Erie canal ..	$3,200 00
Constructing farm bridge, No. 1 (to complete)	1,200 00
Constructing road bridge, No. 1 (to complete)	1,300 00
Constructing road bridge No. 2 (to complete).....	750 00
Constructing road bridge No. 3 (to complete).....	720 00
Constructing road bridge No. 4 (to complete).....	1,400 00
Cast-iron drain pipe.....	300 00
Vertical wall laid dry at swing bridge	1,500 00
Lock-gates (for five locks)	3,800 00
Dredging at junction with Erie canal	400 00
Embankment on canal.....	1,600 00
Engineering and contingencies	1,680 00
Total estimated cost.....	$18,000 00

The work has been completed on the plan above stated, including work not contemplated in the estimates, at an expense of $17,813.86, and the canal was opened to navigation October 6, 1877.

During the progress of the work it was found that the chamber walls to five of the locks, built under contract in 1872, had been crowded in from their established battered lines, varying from one and three-sixteenth inches to three and one-eighth inches. This necessitated dressing off the masonry below the lower gates, and above the lower recess; also cutting the fender timbers through the chambers to conform with the same line. The expense of this work was $548.88.

It was also found, in filling the locks with water, that the masonry in the chamber walls in lock No. 4 was improperly done. An examination resulted in the fact that no cement was used in the construction, except the smearing of the joints on the face with mortar. Excavations, in places, were made in the rear of each wall to a depth of nine feet, and a grout of a proportion of one of hydraulic lime to one of sand was used in filling up the voids throughout the whole length of each wall. The foundation was torn up in places, and where concrete was expected to be found between the timbers there was nothing but clay and coarse gravel. There were used for this work 2,016.67 bushels of lime, amounting to $217.67, and 124 cubic yards of sand, amounting to $110.51. The whole expense, including labor and materials, for this item was $903.45.

The summary of the total expenditures for work done is as follows:

For work originally estimated.....	$14,973 36
For work not estimated.....	2,840 50
Total.....	$17,813 86

Detailed final statement of expenditures, not including engineering, for the completion of Oneida Lake canal with five feet depth of water, as authorized by act chapter 301, *Laws of* 1877, *and pursuant to a resolution of the Canal Board adopted April* 10, 1877.

ITEMS.	Measure.	Quantities.	Price.	Amounts.	Totals.
Material furnished for work estimated.					
Coping stone	Cubic yds.	40.61	$9 00	$365 49	
Hydraulic lime	Bushels	1,690.	10	169 00	
Sand	Cubic yds.	76.70	1 18¾	91 06	
Sand	Cubic yds.	26.	1 34	34 84	
Pig lead	Pounds	854.		47 42	
White oak	Ft. B. M.	518.84	34 00	1,747 05	
White oak	Ft. B. M.	257.	40 00	10 28	
White pine	Ft. B. M.	486.57	20 00	976 56	
Hemlock	Ft. B. M.	202.50	9 50	192 38	
Hemlock	Ft. B. M	509.66	10 00	509 66	
Hemlock	Ft. B. M.	23.02		26 54	
Maple	Ft. B. M.	441.	20 00	8 82	
Stone boat plank	Number	9.	1 00	9 00	
Cast-iron drain pipe and cartage	Gross ton.	1 209-2240		46 07	
Wrought-iron in bridges	Pounds	86.94		418 87	
Cast-iron in bridges	Pounds	74.82		294 22	
Lock iron, wrought and cast	Pounds	94.18		671 04	
Drift bolts in docking	Pounds	1,789.	2½	44 72	
Posts for bridge railing	Number	873.	15	55 80	
Hardware	All			287 36	
Freight, storage and cartage	All			24 75	
Repairs to State scow	All			60 82	
Towing through lake	All			65 00	
Blacksmithing	All			153 88	
Rent of barn and saw				6 35	
Paint for bridges				34 50	
Total materials estimated					$6,341 50
Materials furnished for extra work.					
Ashlar	Cubic yds.	37.89	$4 50	$170 51	
Sand	Cubic yds.	5.20	1 18¾	6 18	
Sand	Cubic yds.	36.25	2 00	72 50	
Sand	Cubic yds.	74.58	40	29 83	
Sand	Loads	8.	25	2 00	
Hydraulic lime	Bushels	1,866¾	10	186 67	
Hydraulic lime	Barrels	20.	1 00	20 00	
Hydraulic lime	Barrels	10.	1 10	11 00	
Am. Portland cement	Barrels	3.	3 15	9 45	
Rosendale cement	Barrels	3.	1 15	3 45	
White pine	Ft. B. M.	720.	20 00	14 40	
Hemlock	Ft. B. M.	1,440.	10 00	14 40	
Blacksmithing	All			75 92	
Total materials for extra work					616 31
Total materials furnished					$6,957 81
Labor performed for work estimated.		No. of days.			
Foreman in charge		104	$5 00	$520 00	
Foreman carpenter		128¾	3 00	386 25	
Carpenters		697	2 00	1,394 00	
Masons		220	2 50	550 00	
Foreman common labor		184 1-10	2 00	368 20	
Common labor		2,605 15-100	1 25	3,256 44	
Water boy		63¾	1 00	63 75	
Water boy		184¾	62½	115 47	
Teams		575 1-12	3 00	1,725 25	
Time-keeper		101	2 50	252 50	
Labor for work estimated					8,631 86
Labor performed on extra work.					
Foreman in charge		34	$5 00	$170 00	
Foreman carpenter		13	3 00	39 00	
Carpenters		67	2 00	134 00	
Masons		31½	2 50	78 75	
Stone-cutters		157¼	2 50	393 13	
Foreman common labor		54¾	2 00	109 50	
Common labor		604½	1 25	755 62	
Water boy		53½	62½	33 44	
Teams		144 5-12	3 00	433 25	
Time-keeper		31	2 50	77 50	
Labor on extra work					2,224 19
Total expenditures					$17,813 86

Following are the actual quantities of work done, and the materials furnished for the above mentioned work. The prices are assumed to get the total cost corresponding with the statement of expenditures:

Quantities.	ITEMS.	Price.	Amounts.	Totals.
1	All grubbing and cleaning		$43 15	
1	All bailing and draining		105 91	
3,117.56	Cubic yards earth excavation	$0 30	935 27	
10,945.18	Cubic yards embankment	20	2,189 03	
928.18	Cubic yards puddling	10	92 81	
82.52	Cubic yards procuring and puddling	30	24 76	
79.59	Cubic yards slope wall (laying)	1 00	79 59	
93.35	Cubic yards laying vertical wall in cement	2 00	186 70	
20.42	Cubic yards laying vertical wall dry	1 00	20 42	
40.61	Cubic yards coping (new stone)	12 00	487 32	
3.54	Cubic yards coping (stone on hand from old con't),	8 00	28 32	
37.89	Cubic yards masonry in cement (new stone)	7 00	265 23	
434.46	Cubic yards masonry (stone on hand from old contract	3 00	1,303 38	
44,494	F., B. M., white oak timber (new)	50 00	2,224 70	
40,316	F., B. M., white oak timber (old)	5 00	201 58	
47,502	F., B. M., white pine timber (new)	45 00	2,137 59	
39,561	F., B. M., white pine timber (old)	10 00	395 61	
62,415	F., B. M., hemlock timber (new)	20 00	1,248 30	
13,526	F., B. M., hemlock timber (old)	5 00	67 63	
298	Number cedar posts	15	44 70	
9	Number stone boat plank	1 00	9 00	
20	Number composite valves (rewooding and plac'g),	10 00	200 00	
1,789	Pounds drift bolts	3	53 67	
25,594	Pounds wrought and cast iron	7	1,791 58	
2,449	Pounds cast iron drain pipe (new)	1¾	42 86	
13,064	Pounds cast iron drain pipe (on hand from old contract)	0¼	32 66	
1,500	Pounds spikes and nails	6	90 00	
854	Pounds lead	8	68 32	
800	Sq. yds., painting four bridges, one coat	12	96 00	
	Painting lock gates		20 00	
	Amount		$14,486 09	$14,486 09
	Material left on hand and transferred to Superintendent of ordinary repairs.			
5,902	F., B. M., white oak timber	34 00	200 67	
1,314	F., B. M., white pine timber	20 00	26 28	
7,733	F., B. M., hemlock timber	10 00	77 33	
737	Pounds wrought iron	7	51 59	
1,170	Pounds cast iron	7	81 90	
100	Pounds miscellaneous wrought and cast iron	6	6 00	
40	Pounds spikes and nails	6	2 40	
3	Number composite valves	10 00	30 00	
74	Number cedar posts	15	11 10	
	Amount		$487 27	487 27
	Total			$14,973 36
	Extra Work.			
1	All bailing and draining		390 33	
855.80	Cubic yards earth excavation	30	256 74	
3,717.45	Cubic yards embankment	20	743 49	
1,125.41	Cubic yards puddling	10	112 54	
10.05	Cubic yards concrete	5 00	50 25	
155.19	Cubic yards grouting lock 4	4 00	620 76	
1,360	F., B. M., white pine timber (new)	45 00	61 20	
2,368	F., B. M., hemlock timber (new)	20 00	47 36	
830	F., B. M., hemlock timber (old)	5 00	4 15	
80	Pounds spike and nails	6	4 80	
1,605	Sq. yds. dressing lock walls	30	548 88	
	Total cost of work			2,840 50
				$17,813 86

The supply of water for this canal is derived from the Rome level of the Erie canal, and is estimated to be as follows:

Twenty lockages	$=\frac{20\times21.750}{24\times60}=$	300 cubic feet per minute.
Leakage and waste at lock.....	=	800 cubic feet per minute.
Evaporation, filtration, etc.,	×5211 =	1,060 cubic feet per minute.
Total.....		2,160 cubic feet per minute.

The structures are: Six stone locks, four of ten feet and two of eleven feet lift; four arch culverts, two of six feet and two of four feet chords; six wooden road bridges; one wooden farm bridge; one wooden swing bridge, at Junction with Erie canal.

The total cost of this canal is as follows:

Under contracts, dated December 18, 1867.....	$350,509 54
Under contracts, dated December 19, 1873.....	36,163 51
Under resolution of Canal Board, dated April 10, 1877...	17,813 86
Total, not including engineering.....	$404,486 91

NOTE.—Includes thirty-four dollars and fifty cents for painting and twenty-two dollars and fifty cents for four and one-half days firemen, at five dollars. To be deducted from above, if not paid.

SUMMARY *of engineering expenses, on both ordinary and extraordinary repairs, for the construction of the enlarged Oneida Lake canal.*

Dates.	Ordinary repairs.	Extraordinary repairs.
For the fiscal year 1867	.....	$943 50
For the fiscal year 1868	.....	5,720 29
For the fiscal year 1869	.....	7,021 67
For the fiscal year 1870	.....	5,231 39
For the fiscal year 1871	.....	3,689 02
For the fiscal year 1872	.....	2,353 97
For the fiscal year 1874	$29 26	5,256 39
For the fiscal year 1875	525 00	6,098 50
For the fiscal year 1876	117 20	1,356 00
For the fiscal year 1877	909 22	2,020 50
Totals.....	$1,580 68	$39,691 23

BLACK RIVER CANAL.

Navigation has been uninterrupted during the season, and the canal is in fair condition.

Considerable repairs have been made to the structures by the superintendent, amounting to $9,579.19.

The prism of the canal was thoroughly cleaned last spring, and many bars removed from the channel in the Black river, below Lyons Falls.

There seems to be an annual expense for dredging the river channel of from $1,500 to $2,000, to keep this portion of the route free from obstructions.

If this canal is to be maintained, it would seem to be economy to make improvements, on the plan of jetties, where necessary, for navigation purposes.

The reservoirs have furnished the usual supply of water, and the Erie canal has received the benefit from one of its most important feeders.

The dam at South lake is a wooden structure, with three openings of 3x5 feet each. It will need repairs and careful watching until rebuilt on the plan submitted to you last year, viz., cast-iron pipe, enclosed in masonry, the cost of which is estimated at $12,000.

The maintenance of all of these works pertaining to the delivery of water to the south end of the summit level, should be charged to the Erie canal.

An outlay of about $3,000 should be made on Forestport feeder, to protect the banks where sloughing has occurred, with stone and brush, and improving the channel for the free passage of the water.

The maximum capacity of discharge into the Lansing Kill, at the south end of the summit level, is 12,000 cubic feet of water per minute, which would result in damages, by washing the intervale lands. In my opinion, an outlay of $3,000 would be ample to prevent these damages, by protecting the banks of the stream with brush and stone.

Reference is made to table No. 3 for ordinary repairs.

CHENANGO CANAL.

The total repairs on this canal for the last fiscal year, as rendered by the superintendent, amount to $4,369.69. If this whole amount had been expended on the reservoirs and feeders at the summit level, and all of their waters brought into the Rome level of the Erie canal at Oriskany, the State would have received a much larger interest on the investment.

SURVEY OF THE ERIE CANAL.

Description.

This division commences at the east line of Oneida county and extends to the east line of Wayne county, a distance of 97.023 miles. It has a north-easterly course from its eastern terminus to Rome, a distance of seventeen miles, thence south-easterly to Canastota twenty-one miles, thence westerly to its western terminus of fifty-nine miles.

The Frankfort level has a length on this division of 3.356 miles, and the water surface is 425.40 feet above mean low tide at Albany, the datum of the survey.

The Rome or Long level has an elevation of 428.40 feet above datum and a water supply of 32.732 cubic feet per minute, derived from reservoirs aggregating an area of 6,559 acres and a total capacity of 4,425,408,000 cubic feet of water. The principal structures are six aqueducts with substantial stone abutments, piers and wings supporting wooden trunks fifty feet in width.

From Butternut Creek aqueduct to lock 47 at Syracuse, a distance of 4.36 miles, the canal bottom was lowered in 1872 for the greater part of this length, on a grade commencing at six inches below canal bottom at the aqueduct and falling to eighteen inches below bottom at the head of lock 47. The work of deepening this portion was never fully completed, but enough has been done to greatly remedy the serious difficulty that had previously existed, by reason of low water during dry seasons, when the waters of the feeders were diverted to the east end of the level, also during the prevalence of high westerly winds and during frequent and numerous lockages.

At Syracuse there are three double lift-locks, Nos. 47, 48 and 49, having an aggregate fall of 27 and 7-10 feet to the Syracuse level, which is 400.70 feet above tide-water. (On this level is the junction of the Oswego canal, extending northward to Lake Ontario, with a total fall of 154 85-100 feet.)

Lock 50 is about two mile west of Syracuse and has a lift of seven feet and seven inches to the Jordan level, which is the summit of this division west of Syracuse, and which is 14 9-10 miles in length. The sources of water supply for this level are principally from Skaneateles and Otisco Lake reservoirs, furnishing 14,912 cubic feet of water per minute. There are two fine aqueducts on this level, spanning Nine-Mile creek, at Camillus, and Skaneateles outlet at Jordan. Lock 51, at Jordan, and lock 52, at Port Byron, have a total descent of 17 feet to the Montezuma level, which is, therefore, 391.571 feet above tide-water, where the waters from the eastward unite with those of lake Erie. An aqueduct at Centerport, crossing the Cold Spring brook, also one at Port Byron, over the Owasco outlet, are fine composite structures; the abutments, piers and wings are of cut-stone masonry, which supports wooden trunks 50 feet in width.

The Montezuma level extends from Port Byron to Clyde, 16 81-100 miles, 9 1-10 miles of which, extending to the east line of Wayne county, are on this division, and reach to the western terminus. In view of all the difficulties attending the construction of this portion of the canal over the Seneca river and across the Cayuga marshes, it may be considered equal to any piece of engineering on this continent. The Richmond aqueduct, an imposing structure, 894½ feet long, crosses the Seneca river three-quarters of a mile west of the junction of the Cayuga and Seneca

canal at Montezuma. Its foundation has an area of two acres, and rests on bearing piles from 20 to 30 feet in length, upon which are raised the substantial stone piers and abutments, supporting 31 finely-dressed arches, each of 22 feet span. The trunk is 50 feet wide; the sides are of white oak, and the floor timbers are of white pine. It contains 10,893 cubic yards of masonry, 110,000 lineal feet of bearing piles, and 1,500,000 feet, board measure, of timber and plank.

It was planned and constructed under the direction of Hon. Van R. Richmond, then division engineer, and was brought into use in 1856.

The canal west of this structure is carried over the Cayuga marshes with an embankment 13 feet above the original surface of the marsh, with an average amount of filling, per mile, of 250,000 cubic yards, and on an average haul of three-quarters of a mile.

In my report of last year I gave as full information in regard to the condition of the prism and mechanical structures as could be obtained from the progress of the survey.

There was included a general description of each level of the canal, showing that in the construction of the enlargement the prism was perfected on the plan adopted, and that there was no original material found above the established grade or canal bottom. There was, however, considerable sediment found on the inner slopes which had accumulated year by year since the completion, varying from five to seventy cubic yards per chain.

Following is a tabular statement showing the

Estimated cost to restore the prism and banks of middle division of the Erie canal to its original condition, length 97.02 *miles, from surveys authorized by act chapter* 425, *Laws of* 1876.

LOCATION.	Length in miles.	Excavation, cubic yards.	Rate of.	Amounts.	Embankment, selected materials, cub. yds.	Rate of.	Amounts.	Totals.
Frankfort level.....	3.356	10.923	25c.	$2,730 75	.....	....	.....	$2,730 75
Rome level.....	55.957	178.501	25c.	44,625 25	150.068	30c.	$45,020 40	89,645 65
Short level	0.188	.82	40c.	32 80	.21	20c.	4 20	37 00
Mile level	0.714	1.032	40c.	412 80	.17	20c.	3 40	416 20
Syracuse level.....	5.014	29.032	40c.	11,612 80	3.072	20c.	614 40	12,227 20
Jordan level.....	14.903	64.880	25c.	16,207 50	5.859	20c.	1,171 80	17,379 30
Port Byron level....	7.793	28.345	25c.	7,086 25	22.000	20c.	4,400 00	11,486 25
Montezuma levels..	9.098	38.782	25c.	9,695 50	15.208	20c.	3,041 60	12,737 10
Totals.....	97.023	351.527	....	$92,403 65	196.245	....	$54,255 80	$146,659 45
Add engineering and contingencies								13,340 55
Total estimated cost....								$160,000 00

In the item of embankment no allowance has been made for the quantities to be removed from the prism, as it should be selected material, to be obtained from other sources.

A list of benches has been prepared giving their location and elevation in reference to low mean tide at Albany; also, the established grade or canal bottom.

The inner slopes of the banks were originally constructed with a "bench" three feet in width at four feet above canal bottom, giving a water-way of 404 square feet. These benches have been removed in various places along the line and full slope walls substituted, increasing the water-way to 428.75 square feet. The following table shows the extent of this work since the enlargement:

LOCATION.	Length in miles.	Water surface above datum.	Vertical Wall, Ch'ns.		Slope Wall, Ch'ns.		Bench Wall, Ch'ns.		Orig. Mat'l, Chains.	
			Tow-path.	Berme.	Tow-path.	Berme.	Tow-path.	Berme.	Earth.	Rock.
Frankfort level.....	3.356	425.40	137	217	131	29	...	22	206	62
Rome level.....	55.957	428.40	112	595	4,282	3,067	71	256	4,291	186
Short level...	0.188	418.23	12	12	.....	....	....	.....	15	.....
Mile level	0.714	407.69	10	55	45	....	..	.....	57	.....
Syracuse level.	5.014	400.70	111	244	253	154	32	.....	401	.. ..
Jordan level	14,903	408.57	31	75	1,155	669	....	454	1,086	100
Port Byron level.....	7,793	402.99	28	69	590	539	....	.....	602	16
Montezuma level.....	9,098	391.57	3	16	709	694	....	.....	728	.....
Totals.....	97,023	.....	444	1,283	7,165	5,152	103	732	7,386	364

Water Supply.

The most important and difficult part of the canal to provide with water is that between lock 47, at Syracuse, and lock 39, at Little Falls, a distance of 80.21 miles, of which 55.957 miles comprises the Rome or summit level.

The total amount furnished from sources, as shown in the table hereto annexed, is only approximately given, owing to the want of accurate measurements of the reservoirs, and of their drainage basins. Of the total supply of 32,732 cubic feet per minute, 13,000 is derived from the water sheds of the Black and Mohawk rivers, and is brought into the canal at Rome. The remaining quantity of 19,732 cubic feet per minute is derived from the reservoirs and natural drainage on the south side of the canal. I have had prepared a profile and a statement, in a tabulated form, which show the distribution of the water supply between these two points. The calculation is based on the following data:

Demand for 200 lockages per day, including leakage and waste, 5,500 cubic feet per minute, at each end. Loss by evaporation, filtration and waste at structures per mile, 244 cubic feet per minute.

Demand for Oneida Lake canal, with 20 lockages per day, with evaporation, filtration, etc., on 5 3–10 miles, 2,162 cubic feet per minute, which loss represents a distance of 8.86 miles of canal. This will explain the additional length shown on the profile.

TABULAR STATEMENT.

Showing distribution of the present water supply between lock 47, at Syracuse, and lock 39, at Little Falls, including demand for the Oneida Lake canal. (*Loss per mile, 244 cubic feet per minute.*) (*See diagram.*)

$$n = g \frac{lp}{F} \cdot \frac{c^2}{2g}$$

LOCATION.	Distance in miles from lock 47.	Cubic Ft. per Minute.		East of Feeder.				West of Feeder.				Total fall in feet from Rome, not including locks.	Sources.		Remarks.
		Demand.	Supply.	Quantity going east.	Miles of canal supplied.	Velocity in feet per minute.	Coefficient of friction.	Quantity going west.	Miles of canal supplied.	Velocity in feet per minute.	Coefficient of friction.		Acres. Reservoirs.	Acres. Drainage basin.	
Lock 47	0	5.500	.....	....	.....	.....	.....	.....	.....	12.825	.....	0.2240	.....	.....	Demand for lockages west.
Butternut feeder	4.86	1.064	1.700	.....	.....	.....	.....	1.700	0.00	15.304	.01306	0.1710	252	30,000	Comprising Jamesville reservoir and Butternut creek.
Limestone feeder	6.58	529	4.391	.....	.....	.....	.....	4.391	2.42	12.576	0.1401	0.1520	626	12,000	Comprising De Ruyter reservoir and Limestone creek.
Chittenango feeder	14.81	2.020	5.641	2.617	10.72	6.100	.01495	3.024	12.39	7.049	0.1478	0.1280	2.118	83,000	Comprising Erieville and Cazenovia lake reservoirs and Chittenango ck.
Cowassalon feeder	24.61	2.391	200	200	0.82	0.990	.....	.....	.....	.....	0.1668	0.1491	Living stream.	6,000	Cowassalon creek.
Oneida Lake canal	26.15	2.162	.....	.....	.....	2.445	.....	.....	.....	2.594	.....	0. 492	....	.....	Demand for canal represents 8.86 miles on diagram.
Oneida feeder	26.15	376	1.000	1.000	4.10	.....	.....	.....	.....	.....	.....	0.1492	Living stream.	25,000	Oneida creek.
Rome feeder	42.21	3.919	18.000	7.969	32.67	18.575	.01204	5.031	20.62	11.729	0.13383	0.0000	2.522	Not measured.	Comprising Black river reservoirs and Mohawk river.
Oriskany feeder	50.11	1.927	6.000	6.000	5 33	28.071	.....	.....	....	.....	0.1048	0.1320	1.041	Not measured.	Comprising Madison county reservoirs and Oriskany creek.
Ilion feeder	69.21	4.660	800	800	0.00	19.072	.....	.....	.....	.....	0.1194	0.7600	Living stream.	Not measured.	Ilion creek.
Little Falls	80.21	2 684	.....	.....	.....	12.825	.....	... ..	....	.....	.....	0.9500	.....	.....	.....
Lock 39	80.21	5.500	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	....	Demand for lockages east.
Demand for Oneida lake canal	8.86	.....	.....	.....	.....	.....	.....	. ....	.....	.....	.....	.....	.....	.....	.....
Totals	89.07	32.732	32.732	18.586	58.64	.....	.....	14.146	35.43	.....	.....	.....	....	.....	

The following is a list of all the structures on the middle division of the Erie canal, and shows the amount and direction of lift of locks:

TABULAR STATEMENT

Showing the mechanical structures upon the Middle Division of the Erie Canal.

ERIE CANAL LEVELS.	Length in miles.	Water surface above datum.	Mechanical Structures.																	
			Double stone locks.			Aqueducts.	Culverts.			Waste-weir.	Bridges.									
			Lift.		Weigh-lock.						Road.		Farm.	Change.	Foot.		Tow-path.	
			No. from Albany.	Lift.			Arch.	Stone box.	Composite.		Iron.	Wood.	Wood.	Wood.	Iron.	Wood.	Iron.	Wood.
Frankfort	3.356	425.400	....	.....	1	....	3	....	....	1	10	2	.....	.....	2	1	....	.....
Rome	55.957	428.400	46	-|- 3.000	....	6	16	1	30	5	21	28	14	2	...	9	1	3
Short	0.188	418.225	47	— 10.175	....	....	....	....	....	....	1	....	.....	.....	....	....	....	. ...
Mile	0.714	407.687	48	— 10.538	....	....	....	..	...	....	2	....	.....	.....	....	....	...	.....
Syracuse	5.014	400.696	49	— 6.991	1	....	5	....	....	1	11	1	.....	... ..	3	....	2	.....
Jordan	14.903	408.568	50	-|- 7.872	....	2	5	....	3	1	1	10	1	.... ..	....	....	....	.....
Port Byron	7.793	402.988	51	— 5.580	....	2	4	1	6	1	7	3	3	.....	....	3	....	.. ..
Montezuma	9.098	391.571	52	— 11.417	....	2	2	....	3	1	3	1	1	2	1	....	....	.....
Totals	97.023	.....	7	.....	2	12	35	2	42	10	56	45	19	4	6	13	3	3

TABULAR STATEMENT.

Showing distribution of the present water supply between lock 47, *at Syracuse, and lock* 39, *at Little Falls, including demand for the Oneida Lake canal.* (*Loss per mile,* 244 *cubic feet per minute.*) (*See diagram.*)

$$n = g \frac{lp}{F} \cdot \frac{c^2}{2g}$$

LOCATION.	Distance in miles from lock 47.	Cubic Ft. per Minute.		East of Feeder.				West of Feeder.				Total fall in feet from Rome, not including locks.	Sources.		Remarks.
		Demand.	Supply.	Quantity going east.	Miles of canal supplied.	Velocity in feet per minute.	Coefficient of friction.	Quantity going west.	Miles of canal supplied.	Velocity in feet per minute.	Coefficient of friction.		Acres. Reservoirs.	Acres. Drainage basin.	
Lock 47	0	5.500	.....	....	.....	.....	.....	.....	.....	12.825	.....	0.2240	.....	.....	Demand for lockages west.
Butternut feeder	4.86	1.064	1.700	.....	.....	.....	.....	1.700	0.00	15.304	.01306	0.1710	252	30,000	Comprising Jamesville reservoir and Butternut creek.
Limestone feeder	6.58	529	4.391	.....	.....	.....	.....	4.391	2.42	12.576	0.1401	0.1520	626	12,000	Comprising De Ruyter reservoir and Limestone creek.
Chittenango feeder	14.81	2.020	5.641	2.617	10.72	6.100	.01495	3.024	12.39	7.049	0.1478	0.1280	2.118	83,000	Comprising Erieville and Cazenovia lake reservoirs and Chittenango ck.
Cowassalon feeder	24.61	2.391	200	200	0.82	0.990	.....	.....	.....	.....	0.1668	0.1491	Living stream.	6,000	Cowassalon creek.
Oneida Lake canal	26.15	2.162	.....	.....	.....	2.445	.....	.....	.....	2.594	.....	0. 492	....	.....	Demand for canal represents 8.86 miles on diagram.
Oneida feeder	26.15	376	1.000	1.000	4.10	.....	.....	.....	.....	.....	.....	0.1492	Living stream.	25,000	Oneida creek.
Rome feeder	42.21	3.919	13.000	7.969	32.67	18.575	.01204	5.031	20.62	11.729	0.13383	0.0000	2.522	Not measured.	Comprising Black river reservoirs and Mohawk river.
Oriskany feeder	50.11	1.927	6.000	6.000	5 33	28.071	.....	.....	....	.....	0.1048	0.1320	1.041	Not measured.	Comprising Madison county reservoirs and Oriskany creek.
Ilion feeder	69.21	4.660	800	800	0.00	19.072	.....	.....	.....	.....	0.1194	0.7600	Living stream.	Not measured.	Ilion creek.
Little Falls	80.21	2 684	.....	.....	.....	12.825	.....	.....	.....	.....	.....	0.9500	.....	.....	.....
Lock 39	80.21	5.500	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Demand for lockages east.
Demand for Oneida lake canal	8.86	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Totals	89.07	32.732	32.782	18.586	58.64	.....	.....	14.146	35.43	.....	.....	.....	....	.....	

The following is a list of all the structures on the middle division of the Erie canal, and shows the amount and direction of lift of locks:

TABULAR STATEMENT

Showing the mechanical structures upon the Middle Division of the Erie Canal.

ERIE CANAL LEVELS.	Length in miles.	Water surface above datum.	Mechanical Structures.																	
			Double stone locks.			Aqueducts.	Culverts.			Waste-weir.	Bridges.									
			Lift.		Weigh-lock.		Arch.	Stone box.	Composite.		Road.		Farm.	Change.	Foot.		Tow-path.	
			No. from Albany.	Lift.							Iron.	Wood.	Wood.	Wood.	Iron.	Wood.	Iron.	Wood.
Frankfort	8.356	425.400	....	.....	1	....	3	....	....	1	10	2	.....	.....	2	1	....	.....
Rome	55.957	423.400	46	-	- 8.000	....	6	16	1	30	5	21	28	14	2	...	9	1	3
Short	0.188	418.225	47	— 10.175	....	....	....	....	....	....	1	....	.....	.....	....	....	....	. ...
Mile	0.714	407.687	48	— 10.538	....	....	....	. .	...	....	2	....	.....	.....	....	....	...	.....
Syracuse	5.014	400.696	49	— 6.991	1	....	5	....	....	1	11	1	.....	... ..	3	....	2	.....
Jordan	14.903	408.568	50	-	- 7.872	....	2	5	....	3	1	1	10	1	.....	....	....	....	.....
Port Byron	7.793	402.988	51	— 5.580	....	2	4	1	6	1	7	3	3	.....	....	3	....	.. ..
Montezuma	9.098	391.571	52	— 11.417	....	2	2	....	3	1	3	1	1	2	1	....	....	.....
Totals	97.023	.....	7	.....	2	12	35	2	42	10	56	45	19	4	6	13	3	3

The following table shows the location, size of all the spillways, including aqueducts and waste weirs:

Levels.	STRUCTURES.	MILES.		SIZE.		SPANS.			ELEVATIONS.			
				Feet.					Caps.		Floor.	
		From east line of Oneida county.	Between structures.	L.	W.	No.	L.	Length of spillway in feet.	C. B.	T. W.	C. B.	T. W.
Frankfort	Ballou waste-weir	1.91	1.91	....	..	..	..	79	7.24	425.64	.....	.....
Rome	Lock No. 46	3.36	1.45	...	..	..	..	....	....	430.43	.....	M. S. 418.40
Rome	Sauquoit aqueduct	5.66	2.30	85	57	3	22	66	6 74	428.14	—0.7	420.70
Rome	Oriskany aqueduct	9.34	3.68	113	55	4	22	88	6.86	428.26	—0.3	421.10
Rome	Waste-weir east of Rome	13.51	4.17	....	..	..	..	100	6.89	428.29	.....	.....
Rome	Fort Bull waste-weir	20.23	6.72	....	..	..	..	100	6.78	428.18	.....	.....
Rome	Ager waste-weir	27.56	7.35	....	..	..	..	69	6.90	428.30	.....	.. ..
Rome	Durhamville waste-weir	33.03	5.45	....	..	..	..	13	6.96	428.36	.....	.....
Rome	Cowassalon aqueduct	34.72	1.69	54	52	2	20	40	6.66	428.06	—0.4	421.00
Rome	Chittenango aqueduct	44.82	10.10	80	50	3	20	60	6.70	428.10	—0.4	421.00
Rome	Poolsbrook waste-weir	47.74	2.92	..	..	..	..	13	..	.....	.....	.....
Rome	Limestone aqueduct	52 82	5.08	80	50	3	20	60	6.96	428.36	—0.6	420.80
Rome	Butternut aqueduct	54.89	2.07	81	50	3	20	60	6.90	428.30	—0.7	420.70
Short	Lock No. 47	59.31	4.42	....	..	..	..	....	...	430.58	.....	M. S. 411.23
Mile	Lock No. 48	59.50	0.19	...	..	..	..	....	....	419.96	.....	M. S. 400.69
Syracuse	Lock No. 49	60.22	0.73	...	..	..	..	....	....	409.58	.....	M. S. 393.70
Syracuse	Barker's waste-weir	60.99	0.77	....	..	..	..	101	6.76	400.46	.....	.....
Jordan	Lock No. 50	65.23	4.24	....	..	..	..	....	...	410.46	.....	M. S. 393.70
Jordan	Camillus aqueduct	68.04	2.81	149	50	4	31	124	6.82	408.39	—0.1	401.47
Jordan	Carpenter's waste-weir	76.42	8.38	....	..	..	..	79	6.87	408.44	.....	.....
Jordan	Jordan aqueduct	78.94	2.52	105	50	4	20	80	6.60	408.17	—0.4	401 17
Port Byron	Lock No. 51	80.13	1.19	....	..	..	..	....	...	410.51	.....	M. S. 395.99
Port Byron	Putnam's waste-weir	83.32	3.19	....	..	..	..	59	6.71	402.70	.....	.....

Port Byron.....	Centerport aqueduct.....	84.91	1.59	76	49	3	20	60	6.80	402.79	—0.1	395.89
Port Byron.....	Port Byron aqueduct.....	87.51	2.60	104	50	4	21	84	6.71	402.70	—0.3	395.69
Montezuma....	Lock No. 52.....	87.93	0.42	....	..	..	..	....	....	404.42	.....	M. S. 384.57
Montezuma....	Crane Brook aqueduct.....	90.77	2.84	79	50	3	20	60	7.06	391.63	0.5	385.07
Montezuma....	Cayuga county mill waste-weir.....	91.84	1.07	...	..	..	..	82	6.75	391.32	.....	.....
Montezuma....	Seneca river aqueduct.....	92.70	0.86	842	50	31	22	682	6.98	391.55	0.5	385.07
Montezuma....	Wayne county line.....	97.02	4.32	....	..	..	..	....	...	.....	.....	.....
			97.02									

The above table shows the elevation of the spillways of all the aqueducts and waste weirs in relation to canal bottom, and mean low tide at Albany. It will be observed that all of them on the Rome level are below the established water surface, varying from one-half inch to four inches.

The profile of the banks on the Rome level shows that at no place are they up to grade, but below the standard of nine feet, varying from three inches to fifteen inches. It is evident that water is wasted at the structures, and the banks are too low to maintain seven feet depth of water. To remedy this, the coping to all spillways should be raised to a hight corresponding to that noted in the above table of aqueduct and waste-weirs, and the banks should be restored to the original hight of nine feet above canal bottom throughout its entire length.

The total cost of engineering for the survey of the Erie canal, as authorized by act chapter 425, Laws of 1876, is:

For the fiscal year ending September 30, 1876.....	$3,060 29
For the fiscal year ending September 30, 1877.....	2,401 61
Total.....	$5,441 90

In conclusion, I have to say that I have been ably assisted by Resident Engineer Richmond, and Assistant Engineer in charge Whitford and his assistants, in all matters pertaining to the duties of this office.

Respectfully submitted.

CHARLES A. SWEET,
Division Engineer.

List of established benches.

Number.	DESCRIPTION.	Elevation above canal bottom.	Elevation above tide-water.
	Frankfort level	0	418.400
1	S. E. corner bottom step E. wing T. P., abut., Green's bridge, E. Utica	13.619	432.019
2	Projection on 2d course W. wing T. P. 3 ft. from W. end, Green's bridge, E. Utica	11.652	430.052
3	S. W. corner bridge seat T. P. abut. starch factory bridge	17.063	435.463
4	S. W. corner bottom step W. wing T. P. abut., Clay street bridge, Utica,	12.481	430.881
5	N. W. corner, W. wall bulk-head waste-weir, E. of Broad street, Utica	7.641	426.041
6	N. W. corner top of 4th column from E. end Utica weigh-lock	11.156	429.556
7	S. E. corner 2d step E. wing T. P. abut, Genesee street bridge, Utica	10.785	429.185
8	W. corner W. wing T. P. abut., Seneca street bridge, Utica	11.788	430.188
9	S. W. corner foundation of S. W. buttress Broadway street foot bridge, Utica	9.307	427.707
10	S. W. corner 6th step from top W. wing T. P. abutment, Potter's bridge, Utica	13.148	431.548
11	Coping lower H. quoin N. side N. lock, lock No. 46	12.033	430 433
	Rome level	.....	421.400
12	N. E corner bottom step E. wing berme abutment, Platt street bridge, West Utica	11.018	432.418
13	East corner bottom step E. wing T. P abut., Smith's farm bridge	12.976	434.376
14	East corner bottom step E. wing T. P. abutment half-way bridge (street car railroad bridge), 2 miles west of Utica	11.594	432.994
15	E. corner bottom step E wing T. P. abut. road bridge, Yorkville	12.837	434.237
16	N. E. corner coping parapet E. wing T. P. Sauquoit creek aqueduct	11.933	433.333
17	W. corner W wing T. P. abut., Clinton street bridge, Whitesboro	12.191	433.591
18	E. corner bottom step E. wing T. P. abut., Westmoreland street bridge, Whitesboro	11.242	432.642
19	E. corner buttress E. wing T. P. abut., Bradley's road bridge	14.896	436.296
20	E. corner bottom step E. wing T. P. abut., Evans' farm bridge	12.332	433.732
21	N. W. corner coping parapet W. wing T. P. Oriskany creek aqueduct	12.419	433.819
22	Projection on stone 2d course near W. angle T. P. abut., Brainard's farm bridge	9.477	430.877
23	E. corner bottom step E. wing T. P. abut., Parkhurst's farm bridge	12.219	433.619
24	S. W. corner W wing T. P. abut. top of 2d course, Kirleys farm bridge,	10.549	431.949
25	S. E. corner, bottom step E. wing T. P. abut., Murphy's road bridge	13.303	434.703
26	S. E corner E. end coping parapet of waste-weir, 4 miles E. of Rome	11.450	432.850
27	N. E. corner bottom step E. wing berme abut., Stanwix road bridge	13.543	434.943
28	S. E. corner S. end coping W. wing culvert over Mohawk feeder at Rome	11.685	433.085
29	S. E. corner E. window on sill in rear of Ethridge and Tuller's store, Rome	14.853	436.253
30	S. W. corner bottom step W. wing T. P. abut. road bridge W. of R. W. and O. R R. bridge	13.508	434.908
31	Projection stone in 3d course near E. wing T. P. abut., Brainard's farm bridge, Fort Bull	11.995	433.395
32	S. W. corner coping parapet wall W. end Fort Bull waste-weir	11.296	432.696
33	Projection 3d stone from end W. wing, ground course T. P. abut., Armstrong's farm bridge, Hawley's basin	9.403	430.803
34	N. E. corner bottom step E. wing T. P. abut. road bridge, 2 miles W. of Fort Bull	13.658	435.058
35	Projection on stone below bottom step E. wing T. P. farm bridge 2¼ miles west of Fort Bull	13.033	434.433
36	Projection on stone below bottom step face E. wing T. P. road bridge, ¼ mile E. of New London	12.035	433.435
37	S. E. corner bottom step E. wing T. P. abut. road bridge, New London,	13.671	435.071
38	Top of masonry under berme bent 2d stone from W. end road bridge, Grove Spring	7.858	429.258
39	Projection 3d stone from E. end E. wing T. P. abut. road bridge 2 miles west of New London	12.206	433.606
40	Projection 4th stone from E. end E. wing 3d course T. P. abutment, road bridge, Happy Valley	12.300	433.700
41	S. E. corner 3d E. wing T. P. abut. E. road bridge, Higginsville	10.914	432.314
42	S. W. corner 3d step W. Wing T. P. abut. W. road bridge, Higginsville,	10.910	432.310
43	S. E. corner 3d step E. wing T. P. abut. road bridge, Dunbarton	11.058	432.458
44	S. E. corner 3d step E. wing T. P. abut. road bridge, ¼ mile east of State bridge	10.964	432.364
45	S. E. corner 4th step E. wing T. P. abut. road bridge, State bridge	11.901	433.301
46	N. E. corner E. end coping parapet wall arch culvert, 1 mile W. of State bridge	7.071	428.471
47	S. W. corner 3d step W. wing T. P. abut. E. road bridge, Durhamville	12.253	433.653
48	S. E. corner 3d step E. wing T. P. abut. iron bridge, Durhamville	11.152	432.552
49	S. W. corner bottom step W. wing T. P. abut., Oneida Creek Road or Bennet's bridge	11.610	433.010
50	N. E. corner bottom step E. wing berme abut., Schollhammer's bridge	11.811	433.211

List of established benches — (Continued).

Number.	DESCRIPTION.	Elevation above canal levels.	Elevation above tide-water.
51	N. E. corner coping buttress E. wing T. P., Cowasselon creek aqueduct,	8.712	430.112
52	S. W. corner 2d step W. wing T. P. abut., road bridge, Lenox basin ...	10.549	431.949
53	N. E. corner coping parapet over face E. wing, culvert 1 mile W. Lenox basin	6.588	427.988
54	S. E. corner 3d step E. wing T. P. abut., Peterboro st. bridge, Canastota.....	11.652	432.052
55	N. W. corner coping parapet, culvert ¾ mile W. of Canastota.....	7.622	429.022
56	S. E. corner 4th step E. wing T. P. abut., Beaver road bridge..	11.572	432.972
57	N. E. corner E. end parapet culvert, 2 miles W. Canastota..	7.511	428.911
58	N W. corner W. end parapet culvert, ¾ mile E. of New Boston.....	7.409	428.809
59	S. E. corner 4th step E. wing T. P. abut., road bridge, New Boston....	11.956	433.356
60	Coping parapet 1 foot from face of W. wing culvert, over Chittenango creek	5.655	427.055
61	S. E. corner 5th step E. wing T. P. abut. road bridge, Canasaraga.....	12.839	434.239
62	N. E. corner coping W. abut., Chittenango Creek aqueduct	8.618	430.018
63	S. E. corner buttress 2d course E. wing T. P. abut., road bridge, Bolivar,	10.905	432.305
64	Projection 4th course corner stone near E. wing T. P., White bridge, E. of Pool's brook	11.757	433.157
65	S. E. corner E. end coping parapet waste-wier, Pool's brook.....	10.451	431.851
66	S. W. corner coping buttress W. wing T. P. abut. road bridge, Kirkville	13.909	435.309
67	N. E. corner coping parapet culvert, ¼ mile W. of Kirkville.....	4.691	426.091
68	S. E. corner S. end retaining wall on E. side bridge approach T. P. side road bridge, Manlius Centre	13.886	434.786
69	S. E. corner 2d step E. wing T. P. about S. and C. V. R. R. bridge, Manlius Centre	10.896	432.296
70	N. W. corner coping parapet over buttress W. wing, Limestone Creek Aqueduct	12.674	434.074
71	N. E. corner coping butteress W. wing culvert, 1 mile W. of aqueduct..	2.005	423.405
72	N. E. corner coping parapet E. wing Butternut Creek aqueduct	12.499	433.899
73	S. E. corner foundation stone E. butteress T. P. abutment road bridge, Thompsons landing.....	9.775	431.175
74	S. E. corner stone door sill W. powder-house.....	8.759	430.159
75	Upper Hollow quoin S. side N. lock, lock 47, Syracuse.....	9.184	430.584
	Short level.....	.....	411.225
76	East Hollow quoin S. side N. lock, Lock 48	8.736	419.961
	Mile level.....	.....	400.687
77	S. E. corner 4th step E. wing T. P. abut , William st. bridge, Syracuse...	12.866	413.553
78	East Hollow quoin S. side N. lock, Lock 49	8.888	409.575
	Syracuse level.....	.....	393.696
79	East Hollow quoin N. side lock Weigh-lock, Syracuse.....	9.012	402.708
80	East wall 9-10 above Bulkhead State race, West Syracuse.....	8.237	401.933
81	S. E. corner 4th step E. wing T. P. abut., Geddes st. bridge, Geddes ...	11.644	405.340
82	South-west corner buttress W. wing T. P. abut., Genesee st. bridge.. Geddes (coping off).....	13.091	406.787
83	S. W. corner coping buttress W. wing T. P. abut., Bridge st. bridge, Geddes.....	13.591	407.287
84	S. W. corner stone over well near Salt bridge, Geddes..	10.057	403.753
85	S. W. corner coping buttress W. wing T. P., road bridge, Gere's Landing	13.461	407.157
86	East Hollow quoin S. side N. lock, Lock 50.....	16.762	410.458
	Jordan level.....	.....	401.568
87	N. E. corner coping parapet culvert ½ mile W. lock 50.....	3.070	404.638
88	N. E. corner coping buttress E. wing T. P. abut. road bridge, Bellisle ..	13.549	415.117
89	N. E. corner coping buttress E. wing T. P. abut. road bridge, Amboy....	13.797	415.365
90	N. E. corner coping parapet E. wing T. P., Nine Mile Creek aqueduct ...	12.475	414.043
91	S. E. corner coping buttress E. wing T. P. abut., Camillus road bridge..	12.718	414.286
92	S. E. corner coping buttress E. wing T. P. abut. road bridge, Newport,	13.368	413.936
93	S. W. corner coping buttress W. wing T. P. abut. road bridge, Memphis,	14.216	415.784
94	N. E. corner coping buttress W. wing T. P., culvert ¾ mile E. of Peru,	4.486	406.054
95	S. W. corner buttress W. wing T. P. abut. road bridge, Peru.	12.352	413.920
96	S. E. corner buttress E. wing T. P. abut. road bridge, Shanty Point	12.566	414.134
97	S. W. corner bottom step W. wing T. P. abut., Buena Vista road bridge. California	11.130	412.698
98	N. E. corner coping buttress W wing, culvert E. of Jordan.....	2.889	404.457
99	S. E. corner coping buttress E. wing T. P. abut., Beaver st. bridge, Jordan.....	13.098	414.666
100	N. W. corner coping parapet E. wing T. P., Jordan aqueduct.....	12.558	414.126
101	East Hollow quoin S. side N. lock, Lock 51.....	8.938	410.506

List of established benches — (Continued).

Number.	DESCRIPTION.	Elevation above canal bottom.	Elevation above tide-water.
	Port Byron level	.....	395.988
102	S. W. corner 3d step W. wing T. P. abut. road bridge, Cold Spring	10.674	406.662
103	S. E. corner 4th step E. wing T. P. abut. road bridge, 1¼ mile W. of Lock 51	12.012	408.000
104	S. E. corner 2d step E. wing T. P. abut. road bridge, ¼ mile E. of Poor Jake's	10.036	406.024
105	S. E. corner 3d step E. wing T. P. abut., Putnam's Farm bridge	11.673	407.661
106	S. E. corner 3d step E. wing T. P. abut., Young's Farm bridge	11.930	407.918
107	N. E. corner E. wall of bulkhead of waste-weir, Weedsport	8.768	404.756
108	S. E. corner 3d step E. wing T. P. abut., Seneca st. bridge, Weedsport	10.913	406.901
109	S. E. corner 3d step E. wing T. P. abut., Brutus st. bridge, Weedsport	11.945	407.933
110	N. W. corner coping E. buttress W. wing, Centreport aqueduct	8.605	404.593
111	S. E. corner 5th step E. wing T. P. abut. road bridge, Centreport	13.233	409.221
112	S. E. corner 5th step E. wing T. P. abut., Utica st. bridge, Pt. Byron	12.471	408.459
113	N. W. corner N. buttress E. wing T. P., Owasco Creek aqueduct	8.509	404.497
114	E. Hollow quoin S. side N. lock, Lock 52	8.432	404.420
	Montezuma level	.....	384.571
115	S. E. corner 4th step E. wing T. P. abut, Hotalling's Farm bridge	11.011	395.582
116	N. W. corner coping parapet W. wing, Crane Brook aqueduct	12.570	397.141
117	S. W. corner 3d step W. wing T. P. abut. iron road bridge, Montezuma	11.561	396.132
118	S. W. corner 3d step W. wing T. P. abut. road bridge, W. of Montezuma	12.095	396.666
119	N.W. corner coping parapet E. wing N. buttress, Seneca River aqueduct	12.408	396.979
120	N.W. corner coping parapet W. wing N. buttress, Seneca River aqueduct	12.259	396.830
121	N. W. corner 3d step W. wing S. abut., Change Bridge at May's Point	12.164	396.735
122	S. W. corner coping parapet, culvert ¾ mile E. Wayne county line	6.319	390.890
123	N. W. corner coping buttress E. wing T. P. abut. road bridge, Wayne county line	12.407	396.978

TABLE No. 1.

Statement of engineering, together with incidental expenses upon ordinary repairs of the Middle Division New York State canals, for the fiscal year ending September 30, 1877, *and paid by the division engineer, under act chapter* 386, *Laws of* 1876.

ERIE CANAL.

NAMES.	Rank.	Number of days.	Rate of compensation.	Amount.	Total.
C. A. Sweet	Division engineer	Salary	$2,400 00	$1,350 00	
C. A. Sweet	Division engineer	Travel		295 02	
Denison Richmond	Resident engineer	Salary	2,000 00	900 00	
Denison Richmond	Resident engineer	Travel		168 30	
D. E. Whitford	Assistant engineer in charge	79	6 00	474 00	
A. V. Meeker	Leveler	105	4 50	472 50	
John S. Killaly	Leveler	207	4 50	931 50	
Frank S. Pecke	Rodman	104	3 50	364 00	
Oscar W. Ferguson	Rodman	77	3 50	269 50	
A. V. Meeker	Rodman	52	3 50	182 00	
					$5,406 82
Incidental expenses.					
Stationery				$122 44	
Postage and telegraph				121 08	
Fuel and light				60 06	
Miscellaneous				377 21	
					680 79
Total for Erie canal					$6,087 61

TABLE No. 1—(Continued).

OSWEGO CANAL.

NAMES.	Rank.	Number of days.	Rate of compensation.	Amount.	Total.
C. A. Sweet	Division Engineer	Salary	$2,400 00	$375 00	
C. A. Sweet	Division Engineer	Travel		82 02	
Denison Richmond	Resident Engineer	Salary	2,000 00	475 00	
Denison Richmond	Resident Engineer	Travel		94 56	
					$1,026 58
Total for Oswego Canal					$1,026 58

CAYUGA AND SENECA CANAL.

C. A. Sweet	Division Engineer	Salary	$2,400 00	$100 00	
C. A. Sweet	Division Engineer	Travel		17 46	
Denison Richmond	Resident Engineer	Salary	2,000 00	150 00	
Denison Richmond	Resident Engineer	Travel		28 50	
					295 96
Incidental Expenses.					
Miscellaneous				$8 50	
					8 50
Total for Cayuga and Seneca canal					$304 46

TABLE No. 1 — (Continued).

BLACK RIVER CANAL.

NAMES.	Rank.	Number of days.	Rate of compensation.	Amount.	Total.
C. A. Sweet	Division Engineer	Salary	$2,400 00	$225 00	
C. A. Sweet	Division Engineer	Travel		59 94	
Denison Richmond	Resident Engineer	Salary	2,000 00	125 00	
Denison Richmond	Resident Engineer	Travel		20 64	
Total for Black River canal					$430 58

ONEIDA LAKE CANAL.

C. A. Sweet	Division Engineer	Salary	$2,400 00	$350 00	
C. A. Sweet	Division Engineer	Travel		96 96	
Denison Richmond	Resident Engineer	Salary	2,000 00	300 00	
Denison Richmond	Resident Engineer	Travel		101 76	
					848 72
Incidental expenses.					
Stationery				$2 50	
Miscellaneous				58 00	
					60 50
Total for Oneida Lake canal					$909 22

TABLE No. 1. — (Continued.)

CHENANGO CANAL.

NAMES.	Rank.	Number of days.	Rate of compensation.	Amount.	Total.
Denison Richmond	Resident Engineer	Salary	$2,000 00	$50 00	
Denison Richmond	Resident Engineer	Travel		9 90	
Total for Chenango canal					$59 90

SUMMARY.

Erie canal	$6,087 61
Oswego canal	1,026 58
Cayuga and Seneca canal	304 46
Black River canal	430 58
Oneida Lake canal	909 22
Chenango canal	59 90
Total for ordinary repairs	$8,818 35

TABLE No. 1 — (Continued).

ERIE CANAL, EXTRAORDINARY REPAIRS, ACT CHAPTER 425, LAWS OF 1876.

NAMES.	Rank.	Number of days.	Rate of compensation.	Amount.	Total.
D. E. Whitford	Assistant engineer in charge..	49	$6 00	$294 00	$294 00
	OSWEGO CANAL.				
Charles Truesdell	Assistant engineer	64	$5 00	$320 00	$320 00
	ONEIDA LAKE CANAL.				
D. E. Whitford	Assistant engineer in charge..	115	$6 00	$690 00	
Charles Truesdell	Assistant engineer	41	5 00	205 00	
Wm. Usborn	Leveler	10	4 50	45 00	
B. P. Ransom	Leveler	3	4 50	13 50	
Frank S. Pecke	Rodman	89	3 50	311 50	
Oscar W. Ferguson	Rodman	116	3 50	406 00	
A. V. Meeker	Rodman	69	3 50	241 50	
W. H. Fursman	Chainman	18	2 50	45 00	
Henry Baily	Chainman	18	2 50	45 00	
					$2,002 50
	Incidental expenses.				
Miscellaneous				$18 00	18 00
Total					$2,020 50

TABLE No. 1 — (Continued).

SURVEY OF THE ERIE CANAL, ACT CHAPTER 425, LAWS OF 1876.

NAMES.	Rank.	Number of days.	Rate of compensation.	Amount.	Total.
D. E. Whitford	Assistant engineer in charge,	69	$6 00	$414 00	
Wm. Osborne	Leveler	95	4 50	427 50	
John S. Killaly	Leveler	105	4 50	472 50	
Oscar W. Ferguson	Rodman	119	3 50	416 50	
Frank S. Pecke	Rodman	119	3 50	416 50	
N. B. Ward	Chainman	26	2 50	65 00	
F. B. Walrath	Chainman	26	2 50	65 00	
R. E. Andrews, Jr.	Chainman	26	2 50	65 00	
					$2,342 00
Incidental Expenses.					
Miscellaneous				$59 61	
					59 61
Total					$2,401 61

SUMMARY OF TABLE No. 1.

Ordinary repairs	$8,818 35
Extraordinary repairs	2,634 50
Survey of Erie canal	2,401 61
Total	$13,854 46

TABLE No. 2.

Statement of extraordinary repair work upon the Middle Division of the New York State Canals for the fiscal year ending September 30, 1877.

ERIE CANAL.

ITEMS.	AUTHORIZED BY		Total length in feet.	Hight of dams in feet.	Estimated cost and amount set apart by Canal Board.	Am'nt done during fiscal year.	Amount remaining to be done.	Remarks.
	Chapter	Laws of						
Constructing pipe sewers at Utica.....	425	1876	240	....	$6,000 00	$5,539 85	.....	Special appropriation — completed.
Oneida Creek feeder dam	425	1876	89	7	4,200 00	1,446 36	$2,753 64	....
Limestone Creek feeder dam.....	425	1876	100	5	2,100 00	.....	2,100 00	No timber delivered.
Skaneateles Creek feeder dam.....	425	1876	60	4⅓	1,100 00	125 59	974 41	....
Totals.....	....	....	....	....	$13,400 00	$7,111 80	$5,828 05	

TABLE No. 2 — (Continued).

OSWEGO CANAL.

Constructing sloping aprons to Oswego River dams.

RIVER DAMS.	AUTHORIZED BY		Length of dam in feet.	Length built previous to 1876.	Length built during fiscal year.	Length remaining.	Engineer's estimate and amo't set apart by the Canal Board.	Am'nt done during fiscal year.	Unexpended balance lapsed.	Estimated cost to complete entire length.
	Chapter	Laws of								
Phœnix dam	425	1876	440	170	110	160	$4,000 00	$2,344 00	$1,656 00	$3,500 00
Fulton dam	425	1876	503⅝	0	199	304⅝	6,000 00	5,173 90	826 10	8,000 00
Van Buren dam	425	1876	662	98	277	287	8,000 00	5,548 02	2,451 98	5,800 00
Minetto dam	425	1876	445	196	113	136	3,000 00	2,169 13	830 87	2,700 00
Totals	....	....	2,050⅝	464	699	887⅝	$21,000 00	$15,235 05	$5,764 95	$20,000 00

TABLE No. 2 — (Continued).

ONEIDA LAKE CANAL.

Completion of canal with five feet depth of water.

NAME OF CANAL.	AUTHORIZED BY		Appropriation.	Estimated cost and amount set apart by Canal Board.	Am't done during fiscal year.	Remarks.
	Chapter	Laws of				
Completion of Oneida Lake canal.....	301	1877	$48,231 20	$18,000 00	$17,813 86	Completed.

TABLE No. 3.

Statement of miscellaneous work upon ordinary repairs done by the Superintendents, under the supervision of the Engineer Department, for the fiscal year ending September 30, 1877.

ERIE CANAL.

Section No. 5 — 38.106 miles in length.

Character of work.	Am't done during fiscal year.	Total amount on sections.
Repairing lock No. 46.....	$149 27	
Repairing aqueducts on section.....	775 44	
Repairing waste-weirs on section	59 15	
Repairing culverts on section.....	347 89	
Repairing bridges on section.....	4,116 66	
Rebuilding bridges on section.....	257 27	
Raising banks on section	9,186 46	
Cleaning out prism on section.....	1,971 95	
Repairing slope wall on section.....	1,761 01	
Repairing docking on section.....	406 13	
Cleaning out creeks.....	3,048 85	
Repairing dams.....	92 44	
Total for section No. 5		$22,172 52

Section No. 6 — 31.004 miles in length.

Repairing locks on section	$549 71	
Rebuilding Camillus aqueduct.....	5,495 43	
Repairing Butternut and Limestone aqueducts.....	54 03	
Repairing waste-weirs.....	262 54	
Repairing weigh-lock at Syracuse.....	101 26	
Repairing bridges on section	2,177 29	

Character of work.	Am't done during fiscal year.	Total amount on sections.
Rewooding and inserting iron needle beams in Grape street bridge, Syracuse	$879 81	
Constructing bridge at Jamesville	420 38	
Raising banks	3,398 25	
Cleaning out prism	1,101 75	
Cleaning out creeks	63 42	
Repairing dams	41 29	
Repairing slope wall	235 38	
Repairing docking	232 31	
Repairing vertical wall	204 12	
Total for section No. 6		$15,216 97
Section No. 7 — 27.913 miles in length.		
Repairing lock No. 51	$78 85	
Repairing lock No. 52	323 37	
Repairing aqueduct at Jordan	39 40	
Repairing Centreport aqueduct	2 00	
Repairing Crane Brook aqueduct	17 75	
Repairing Richmond aqueduct	951 66	
Rebuilding St. John's bridge at Weedsport,	298 72	
Rebuilding Young's bridge at Weedsport	291 09	
Repairing approaches, etc., at Cold Spring	20 79	
Rewooding and inserting iron needle beams in Utica street bridge, at Port Byron	619 73	
Repairing bridge at Skaneateles	130 17	
Repairing bridges at Newport, Jordan, Weedsport, Hamilton's, Centreport, Port Byron and Montezuma	1,041 99	
Raising and repairing banks	2,602 43	
Cleaning out prism	469 52	
Cleaning out creeks	208 82	
Repairing dam at Skaneateles	44 50	
Repairing dam at Jordan	13 27	
Repairing dam at Port Byron feeder	16 48	
Repairing slope wall at Port Byron and May's Point	26 84	
Repairing docking, Memphis, Jordan, Weedsport and Montezuma	47 99	
Repairing breaches, Port Byron feeder and Montezuma	330 35	
Removing brick wall debris at Jordan	32 85	

Character of work.	Am't done during fiscal year.	Total amount on sections.
Repairing vertical wall at Memphis.....	$15 18	
Cutting ditch west of lock 51.....	111 59	
Cutting ditch between Memphis and Peru..	198 75	
Protection wall west of Seneca river.....	73 21	
Total for section No. 7.....	.....	$8,007 30
Total for Erie canal.....		$45,396 79
OSWEGO CANAL.		
Section No. 1.		
Repairing locks on section	$1,693 74	
Rebuilding bridges at Greene Point, and below lock 3	1,917 97	
Repairing bridges on section.....	682 56	
Raising banks on section.....	2,225 86	
Cleaning out prism on section	654 75	
Repairing dams on section.....	2 50	
Repairing slope wall on section.....	164 38	
Repairing docking on section.....	2,611 00	
Building coffer dams.....	191 43	
		$10,144 19
Section No. 2.		
Repairing locks on section	$722 72	
Rebuilding lock gates on section	2,379 60	
Rebuilding bridges on section.....	1,452 34	
Repairing bridges on section.....	466 20	
Repairing dams on section	199 85	
Raising banks.....	1,740 33	
Cleaning out prism	176 89	
Repairing docking.....	274 40	
Repairing breaches	306 85	
		7,719 18
Total for Oswego canal.....		$17,863 37
CAYUGA AND SENECA CANAL.		
Repairing locks	$1,174 83	
Rebuilding lock gates.....	856 04	
Repairing bridges	1,805 34	
Raising banks.....	1,646 34	
Repairing dams	69 17	
Repairing docking.....	646 69	
Total for Cayuga and Seneca canal.....		$6,198 41

BLACK RIVER CANAL.

Character of work.	Am't done during fiscal year.	Total amount on sections.
Repairing locks	$2,820 22	
Rebuilding lock gates	2,477 64	
Repairing aqueducts	294 00	
Repairing waste-weirs	212 75	
Repairing culverts	142 50	
Repairing bridges	1,302 22	
Rebuilding bridges	915 05	
Dredging	1,595 19	
Raising and repairing tow-path and removing bars	1,681 50	
Cleaning out prism	1,324 68	
Repairing dams	337 82	
Repairing docking and sluices	1,076 99	
Repairing road to reservoir	203 49	
Total for Black River canal		$14,384 05

WESTERN DIVISION.

ANNUAL REPORT OF WILLIAM H. SEARLES, DIVISION ENGINEER, FOR THE FISCAL YEAR ENDING SEPTEMBER 30, 1877.

ENGINEER DEPARTMENT, WESTERN DIVISION,
ROCHESTER, N. Y., *October* 1, 1877.

Hon. JOHN D. VAN BUREN, Jr., *State Engineer and Surveyor:*

SIR. — In compliance with the regulations established under act chapter 169, Laws of 1862, governing the engineer department, I have the honor to present to you my report, upon the western division of the New York State canals, for the fiscal year ending September 30, 1877.

The canals and navigable feeders, embraced in this division, are as follows:

	Miles.
Erie canal, from south line of Wayne county to Buffalo	148.90
Genesee River feeder, at Rochester	2.25
Genesee Valley canal, from Rochester to Mill Grove	113.50
Genesee River feeder, at Oramel	.75
Dansville branch of Genesee Valley canal	11.00
Chemung canal, from Watkins to Elmira	23.00
Chemung Canal feeder, from Corning to Horseheads	16.00
Crooked Lake canal, from Penn Yan to Dresden	7.66
Total	323.06

The unnavigable feeders have an aggregate length of fourteen miles, of which eleven and a-half pertain to the Erie canal, and the balance to the Genesee Valley canal.

The sources of water supply on this division are as follows:

FOR ERIE CANAL.

Lake Erie.
Tonawanda creek, at Pendleton.
Tonawanda and Oak Orchard creeks, at Medina.
Genesee Valley canal, at Rochester.
Genesee river, at Rochester.

FOR GENESEE VALLEY CANAL.

Allen's creek, at Scottsville.
Genesee river, at Mount Morris.
Canaseraga creek, two miles north of Dansville.
Mill creek, at Dansville.
Wiscoy creek, at Mixville.
Genesee river, at Oramel.
Rockville reservoir, near Belfast.
Two branches of Black creek, on summit level.
Oil Creek reservoir, on summit, two miles north of Cuba.
Champlain and Griffin creeks, at Cuba.
Ischua reservoir, at South end of summit level.
Oil creek, at foot of lock No. 101, near Hinsdale.
Haskell creek, on extension.
Dodge creek, on extension at Portville.
Oswayo creek, on extension south of Portville.
Allegany river, at head of canal, at Mill Grove.

FOR CHEMUNG CANAL.

Chemung river, at Corning.

FOR CROOKED LAKE CANAL.

Crooked lake and outlet, at Penn Yan.

ERIE CANAL.

Water Supply.

Lake Erie is the main source of supply for the Erie canal, and is ample under all ordinary circumstances, to furnish water for navigation over the entire distance from Buffalo to the eastern boundary of the division.

Tonawanda creek furnishes its entire volume to the canal, its bed being used for slack-water navigation from Pendleton to Tonawanda, a distance of twelve miles.

The feeders from Oak Orchard creek and Genesee river are used only at the opening of navigation, and, in case of emergency, during the summer season. The Genesee canal has supplied water through one open paddle during the present season, without which the navigation of the Erie at Rochester and eastward, would have been somewhat defective.

TONAWANDA AND OAK ORCHARD CREEK FEEDER.

This work, which is eleven and a-half miles in length, extends from a dam on Tonawanda creek, in Genesee county, to the Erie canal, at Medina. It consists of

	Miles.
1. An open cut, forty feet wide, and two feet depth of water, from Tonawanda creek to Oak Orchard creek, through Tonawanda swamp, receiving the drainage of the swamp from the east, length	4.05
2. The excavated channel of Oak Orchard creek, cut mostly through solid rock, fifty feet wide by two feet deep, length,	3.20
3. The natural channel of Oak Orchard creek as far as the dam at Medina, length	3.20
4. The race-way from the dam to Erie canal, length	1.10
Total miles	11.55

The Tonawanda dam is built of timber, with substantial stone abutments, and is in good order. Its height is two feet six inches, and length 150 feet.

The open cut has a bulk-head near the dam which, in time of flood, is closed, and shuts off all the water of the creek, but is opened during the dry season, and passes the entire ordinary flow of the creek.

The channel of Oak Orchard creek was excavated in the year 1863, at a cost of over $16,000, to provide for the water flowing through the open cut, without backing up the water of the creek on the lands above.

The feeder affords a valuable water power at Shelby Centre and at Medina, the fall in both places being high. The discharge of water is estimated at 1,600 cubic feet per minute. The feeder has also been of very great advantage to the swamp lands lying west of the open cut by the drainage afforded, and protection from floods, thus reclaiming them, and converting a useless morass into a fertile and well cultivated district.

The feeder is of little service to the canal at the present time, the water being allowed to discharge under the aqueduct. In case of necessity, however, it could be turned into the canal, and by bottoming out the open cut, which is much obstructed by mud and grass, the discharge could be much increased.

GENESEE RIVER FEEDER.

The Genesee River feeder of the Erie canal is situated on the east bank of the river, in the city of Rochester, and is two and a quarter miles long. It has a substantial bulk-head at the upper end. The State dam above the feeder is designed to raise the water a little above the

level of the canal, but a portion of the dam was removed several years ago, so that, except in flood time, the river level is below that of the canal.

By restoring the dam, which can be done at small expense, the feeder may be made to supply the canal as formerly. Should a break occur west of Rochester, this feeder would prove invaluable to the interests of navigation.

The feeder is in bad order. The bank on the river side has been so eroded by the action of ice and freshets that, for several hundred feet, it is less than five feet wide on top, with a slope toward the river steeper than one to one, and fifteen feet high. There is great danger of a break occurring in this bank, especially if the feeder were in use. It is exposed to the river, and is liable to be washed away in time of flood.

The feeder has accumulated a large amount of sediment, and is nearly choked with aquatic plants, rendering it nearly useless as a feeder. It should be thoroughly bottomed out, and the banks strengthened, no work having been done on it for years. It is estimated that at least $10,000 will be required to put the feeder in good order. In case of the entire abandonment of the Genesee Valley canal, this feeder would necessarily come into constant use, to regulate the eastern end of the long level, into which it empties.

NAVIGATION.

The navigation of the Erie canal has been without interruption during the present season. No break of any serious consequence has occurred, although several leaks, which were rapidly assuming dangerous proportions, have been detected and stopped. The waste-weirs were adjusted in the spring according to the levels of the Erie survey, resulting in a better regulated stage of water than previously existed. During May and June last, the water throughout the division coincided closely with the marks fixed for its regulation, and was quite steady, except as affected by the wind. About July first, the eel grass and other water plants began to show themselves, and in a short time so filled up the prism as seriously to impede the flow of water on the long levels. Careful measurements, taken during July, show that the water requires an additional head of one-quarter of an inch per mile, in order to overcome the obstruction of the grasses. This additional head could not be given at Lockport, owing to the low state of the berme banks, which, in many places, were but a few inches above the regular surface, and hardly safe at the ordinary stage. As a consequence, the water became quite low at Rochester, but, by feeding in part from the Genesee Valley canal, and securing a very economical use of water eastward, the levels were kept up to a point that would sustain navigation.

The State tug from Buffalo was employed to remove the grass, on the long level, by dragging heavy chains behind it, and was tolerably successful after several trips between Lockport and Rochester.

Little effort was made on the other levels to uproot the grass, as the water could be raised on them sufficiently to give the necessary flow.

The grass is a serious hindrance to boats, and causes great inconvenience by gathering upon the tow-lines. Any means of quickly removing the grass from the prism of the canal, would prove of great value to navigation.

DIVISION WALL, BLACK ROCK HARBOR.

This work remains the same as it was left by the contractor two years ago, except for the deterioration of unfinished portions. The length built is 10,455 feet, the part unbuilt is 897 feet, or eight per cent of the whole, and comprises two gaps in which no work has been done. These gaps render almost valueless the work that has been finished at a cost of $337,529.69, when the whole might be completed by an expenditure of $35,000 more. Meanwhile a large bill of repairs is annually incurred, amounting to thousands of dollars, which would be avoided were the wall completed and the canal separated from the harbor. It is of great importance to navigation, and also as a measure of economy, that this wall be completed. The harbor has been rapidly silting up, so that islands of large extent now appear, where a few years since was deep water, and there is barely a navigable channel for lake craft left at this time. The reason for this is, the main supply of water for the harbor comes down the canal and passes through the gaps in the division wall to supply the large number of flouring mills, which obtain their water power from the harbor. The gaps being near the lower end of the harbor, tend to create a slack water in the harbor above them in which the deposits take place. Were the gaps closed, not only would the canal be saved from a current detrimental to navigation, but the harbor would be improved by the increased current which must then flow through it, scouring out a channel for itself and improving the harbor navigation, which now is only maintained by the assistance of the State dredge.

BUFFALO SEWERAGE.

The Main and Hamburg street canal, a short extension of the Erie canal, in the city of Buffalo, occupies the old bed of the Little Buffalo creek. It was originally built by the State in the interest of property holders in that vicinity, but owing to sewage that has been allowed to discharge into it, it has become an open cesspool vitiating the atmosphere of the neighborhood with its unwholesome fumes. The city of Buffalo pays $3,000 annually to keep in motion a submerged wheel drawing water from Ohio basin, and giving a very slight current to these

otherwise stagnant waters. The Erie canal receives all the impurities thus sent forward, and is made the outlet for the sewage of the entire city, greatly to the damage of all boating interests.

There are forty-four sewers discharging into the canal system in Buffalo, having a total length of eighty-four miles and draining an area of 4,220 acres.

On the completion of the system now in progress of construction there will be over 100 miles of sewers, draining 10,000 acres of city property. This large system, instead of discharging as at present into the Erie canal should discharge into Niagara river, but to effect this it will be necessary for the city to build a belt sewer parallel in general to the canal and discharging under the bottom at two points, by large culverts which should be constructed by the State. The expense to the city is estimated by the city engineer at $2,000,000, and the expense to the State would probably be about one-tenth of that sum.

Erie Basin.

The Erie basin lies at the entrance to Buffalo harbor, and communicates with the canal through several slips. It is 2,000 feet long by 800 feet width, and is protected from the lake by a breakwater of heavy masonry, with a foreshore of rip-rap. The sand washed into it from the lake makes dredging necessary. Most of the abandoned craft which were sunk in this basin last year have been raised and removed, but others are taking their places and should be disposed of, and measures taken to prevent the deposit of worthless hulks here which have to be removed at State expense.

Bird Island Breakwater.

This structure, 2,200 feet in length, extends southerly from the old Bird Island pier, at the entrance to Black Rock harbor, and is designed specially to protect the Erie canal against the encroachments of the lake. It was completed to its present limit in 1874, but was partly destroyed by a storm the same year. After being repaired it was further damaged the following year, and so remained until the fall of 1876, when its repair was undertaken by the superintendent under the direction of the engineer. The work consists of a line of cribbing twenty feet wide, standing on the bottom, in water from eight to twenty-five feet deep, filled with loose stone, and decked over with plank. The deck is about four feet above low water mark. The cribs are built of hemlock timber twelve inches square, and were originally fastened together with twenty-four inch drift bolts one (1) inch in diameter, driven in holes bored of the same size. It was owing to this insufficient fastening that some of the top portions were carried away by the force of the waves.

In the late repairs pine timber was used, and drift bolts one inch square and forty inches long were driven into holes one and one-sixteenth inches diameter, a washer being used upon the top courses to prevent those timbers slipping over the heads of the bolts. The bolts were placed, usually, five feet apart, and driven at a slight inclination to the vertical. The foreshore which formerly consisted of small stone, and which had largely disappeared, was now repaired with stone blocks, the smallest of which contained not less than twenty-seven cubic feet. Thus fortified, the breakwater has safely withstood all storms, and is now in good condition, although some of the large stones have been thrown up by the waves and landed on deck.

The expense of this repair was $12,361.78.

The breakwater is 2,500 feet shorter than the original design, and hence affords only half the protection that was intended. Moreover, its hight above low water leaves it nearly, or quite, submerged by the high water which accompanies the severest storms, so that it does not entirely destroy the violence of the waves passing over it. The canal is consequently still exposed to the lake and has suffered considerable damage at times.

A heavy plank fence four feet high, having piles for posts, has been built along the tow-path, where exposed to the lake, and has served a good purpose thus far for local protection.

LOCKS.

There are twenty-three (23) locks pertaining to the Western Division of the Erie canal, all built of ashlar masonry. Of these nineteen (19) are lift-locks, numbered from No. 53 to No. 71, inclusive, and located between Clyde and Lockport. They all have double chambers, (110) one hundred and ten by (18) eighteen feet each.

At Sulphur Spring, near Pendleton, is a guard-lock of one chamber, 110 by 20 feet, usually standing open, but having a lift depending upon the stage of water in Tonawanda creek.

At Tonawanda is the "river lock," a single lift-lock communicating with the creek below the dam, and so with the Niagara river. The chamber is (110) one hundred and ten feet by eighteen (18) feet, with a four foot lift.

At Black Rock is a guard-lock of two chambers (112) one hundred and twelve by (20) twenty feet each, with a lift of one foot and two inches, or more, depending on the stage of water in Lake Erie. Also, a ship lock, communicating with Niagara river, of one chamber (200) two hundred by (36) thirty-six feet, and four (4) feet lift.

The locks are generally in good condition, requiring the usual amount of ordinary repairs only.

Lock No. 60, Lower Macedon, was thoroughly repaired before navigation opened, by the superintendent, and is now in good order. The masonry of the locks generally is in good condition, requiring only some pointing. The lock-gates on section 8, and particularly those at Lockville, are in need of extensive repairs. The paddles generally leak very badly, and the paddle levers are worn out. There is a great and constant waste of water in consequence. Some of these gates are old and liable to accident at any time, and there are no duplicates on hand in case of failure. A considerable outlay in this direction should be made before another season of navigation. On the other sections the lock-gates and valves are generally in better order, requiring ordinary repairs only.

The increasing business at Tonawanda renders the single lock at that place inadequate to pass the boats and rafts from the river without great delay in many instances. The communicating basin is also too narrow. The lock should be doubled and the basin enlarged. The plans for that work were prepared two years ago. The work was estimated to cost $60,000.

At Lockport, the wall supporting the race-way above lock No. 70, on the south side, has bulged out toward the lock by the action of the frost, and the leakage from the race is considerable. While the movement is gradual, it renders the wall unsafe. About seventy-five (75) feet should be taken down and relaid. The cost of this repair is estimated at $1,800.

For a table of locks, see report of Erie survey, annexed.

STOP GATES.

LOCATION.	Width of water-ways.	Number of water-ways.	When built.	Number of gates.	Kind of gates.	Facing toward.	For protection of what.	Distance protected, miles.	Original cost.
	ft. in.								
Bushnell's basin	40 6	1	1859	1	Tumble	East	Irondequoit bank	1.60	$4,046 53
Cartersville	41 0	1	1859	1	Tumble	West	Irondequoit bank		5,734 38
Rochester	34 0	2	1871	4 pairs.	Miter	East and west	Deep hollow	3.61	9,732 91
Adam's basin	41 0	1	1872	2 pairs.	Miter	East and west	High bank	13.09	8,283 40
Holly (East)	39 6	1	1872	1 pair.	Miter	East	Holly bank	10.17	2,998 07
Holly (West)	40 6	1	1859	1	Tumble	West	Holly bank	2.23	4,365 00
Medina (East)	40 0	1	1858	1	Tumble	West	Road culvert	18.21	5,557 14

The above table gives general information concerning this class of structures; they are all in working order, though some of them are in need of repairs to masonry and bulk-head.

The stop-gate near Adam's Basin is built upon a soft red sandstone, through which the water finds its way when the gates are shut. The bottom should be concreted, and other repairs made. Estimated cost of repairs, $350.

The Rochester stop-gate has been injured by boats striking the center pier, which is only a foot above water, and not easily seen. The east end of the pier has been thrown down. This requires repair, and at the same time a wooden structure should be built on the pier, high enough to be always visible, but so as not to interfere with tow lines.

The distance from Lockport to the Medina stop-gate is nineteen and three-tenths (19 3–10) miles, averaging one hundred (100) feet in width, and seven and eight-tenths (7 8–10) feet in depth, all of which would be drained in case of a break occurring between these points.

There should be three new stop-gates built on this section of canal, reducing the length exposed to any one break to six or seven miles. These could be built at an estimated cost of $6,000 each, and would serve to protect from damage, for which the State would be liable, a hundred times that amount of property.

AQUEDUCTS.

There are four (4) aqueducts on this division of the Erie canal, as follows:

LOCALITY.	Total length, feet.	Number of spans.	Length clear span, feet.	Hight to coping from bed of stream, feet.	Character of trunk.	Width of waterway, feet.	Depth of water, feet.	When built.	Original cost.
Lyons	130	5	20	18	Wood.	50	7.00	1848	$42,106 18
Palmyra	94	3	24	19	Wood.	50	7.20	1857	34,423 36
Rochester	800	2 7 1	25 52 30	27	Stone.	43	7.67	1842	445,387 00
Medina	80	1	53	35	Stone.	85	8.20	1855	50,811 00

The Medina aqueduct is in a very leaky condition, and has received no repairs for several years. The water pours out of the joints from all points of this expensive structure. It will be necessary to take up the entire bottom of the canal over the aqueduct, and fill existing crevices with puddle and concrete. Parts of a previous structure, which are covered up, have doubtless increased the tendency to leak, and it may be necessary to remove some of these. A thorough repair of this structure is estimated to cost $1,500, and is recommended as of great importance. Some trifling repairs were made upon the berme wall adjoining, last spring, but these had no affect on the leakage.

WASTE-WEIRS.

In the report of the Erie survey will be found a table descriptive of these structures. The spillways have generally been corrected to agree with proper elevation of weir, as given in this table. The Lockville weir is still several inches too high, but it was thought best not to reduce it until the leaks in the gates of locks Nos. 57 and 58 have been stopped.

In addition to the weirs mentioned in the report, there is one on the tail-race leading from the Lockville Mills to the canal. The spillway of this weir is above regular water mark, and there are no gates. It consists of a timber bulk-head ten feet long. Any water discharging at this weir is lost to the canal. It is intended for use only when the canal is to be drawn off, and the water from the mills may not be allowed to enter the canal.

The waste-weirs generally stand in need of thorough repairs. The valves are generally in a leaky condition, some of them refuse to close properly, and altogether a large amount of water is thus wasted. These should all be put in good order during the spring repairs.

The gates at Tonawanda dam have been repaired recently by the superintendent of section 11, at considerable expense.

The waste-weir at Eagle Harbor formerly had three gates which were washed out several years ago, with the abutments, leaving only a portion of the spillway, a stone structure. This work should be restored. Without these gates there is no means of drawing off water for a distance of eleven miles, from Albion to Medina. Estimated cost, $1,600.

The waste-weir at Medina requires rebuilding as to the spillway wall, from which the cement has all washed out. The gates are in fair condition, having been repaired last spring.

The masonry generally of the waste-weirs requires repointing. That at Carterville, a very high structure, is in a dangerous condition for want of attention to this matter.

At Mabee's the looseness of the joints allowed the water to find its way behind the masonry, nearly resulting in washing away the bank. The injury was discovered in time, however, to prevent a serious break.

BRIDGES.

There are 220 State bridges on the Erie canal, western division, distributed as follows:

	MATERIAL.				CLASSIFICATION.					
	Iron.	Wood.	Iron and wood.	Total.	Highway.	Farm.	Change.	Highway and change.	Tow-path.	Lift, swing or draw.
Section VIII	14	28	0	42	31	8	2	1	0	0
Section IX	37	18	12	67	61	2	2	0	2	3
Section X	30	26	3	59	58	1	0	0	0	1
Section XI	36	12	4	52	34	4	2	3	9	6
Totals	117	84	19	220	184	15	6	4	11	10

Additional to the above are 52 wooden bridges over State ditches connected with the Erie canal, as follows: On section 8, two (2) wooden bridges; on section 9, one (1) road bridge; on section 10, in Pendleton township, eight (8) road bridges and one (1) farm bridge, and on section 11, in Wheatfield township, five (5) road and thirteen (13) farm bridges; in Tonawanda township, nine (9) road and thirteen (13) farm bridges. Of these, the most important are three Whipple truss bridges, in the village of Tonawanda, having 61 feet clear span; a few others are truss bridges of about 30 feet span, and the remainder are composed of timber stringers merely. They are generally supported on pile or timber bents.

On section 8, No. 7, Barker's farm bridge has received extensive repairs, by splicing the ends of lower chords, and replacing end braces with new, etc. This and other bridges have been repaired in floor plank and joists. Many of the bridges have been raised several inches, so as to clear 12 feet from the water surface, having been found to be too low.

On section 9 the following bridges have been rebuilt during the year: No 48, Wapping; wood, with iron chords and iron floor beams. No. 56, Cook's; wood, with iron chords. No. 62, Culvert street, Rochester; wood, with iron chords. No. 88, Scott's; wood, with iron chords. No. 93, Finley's; wood, with iron chords, and No. 102, Crissey's; cast iron, from material saved from the old St. Paul street bridge, Rochester, and wrought-iron floor beams, new. Other bridges have received the usual amount of repairs to floors and floor beams.

On section 10 the following bridges have been rebuilt during the year: No. 118, McGuire's; wood, with iron chords. No. 137, Hastings; cast-iron arch and wrought-iron floor beams, from the material of the old Ferry street bridge, Buffalo. No. 143, town line; wood throughout, built by the superintendent without the concurrence of the engineer. No. 160, Cady's, Lockport; wood, with iron chords and iron floor beams. Nos. 166 and 167, wooden approaches over tow-path and berme to Heacox and Hawley bridges. Other bridges have received the usual amount of repairs to floors and floor beams.

On section 11, No. 171, Tonawanda creek tow-path bridge has been rebuilt in three (3) equal spans, wood, with iron chords; the last abutment was taken down, the foundation strengthened with additional piles and rebuilt in cement masonry. No. 172, Ransom Creek tow-path bridge; all wood; rebuilt by the superintendent without the concurrence of the engineer. No. 177, Main street, Tonawanda; north abutment rebuilt and foundations strengthened by the superintendent, under the direction of the engineer, iron floor beams inserted and new floor laid. No. 179, Seymour street, Tonawanda, received new oak floor beams, joists and floor. Other bridges received the usual amount of repairs to floors and floor beams.

The Pine street bridge at Lockport remains as at the date of the last report. It should be replaced by a wrought-iron structure. The same is true of the Prime street bridge, Buffalo.

The York street change bridge, and the tow-path bridges over slips 1 and 3, must be rebuilt before the opening of navigation in 1878. The change bridge, No. 87, at Rochester, must also be rebuilt. Several farm bridges on section 8 are likely to fail within a year from this date.

During the present season all the bridges over the Erie canal, on the western division, have been inspected minutely and measured carefully

in all their details. Many defects have thus been discovered and corrected, and the bridges are believed to be in better condition in consequence than ever before. All the measurements taken have been recorded in a book specially provided for that purpose, which forms a permanent bridge record. From this record the following table of bridges has been prepared, exhibiting the number and character of all the canal bridges at the present date.

Table of State bridges, Erie canal, Western Division, 1877.

Number.	NAME.	Class.	Plan.	Material.	Date of erection.	Clear span. ft. in.	Trusses. Number.	Hight. ft. in.	Number of panels.
	SECTION VIII.								
1	Wayne County Line	Highway	Whipple truss	Wood	1869	72 3	2	7 9	6
2	Pit lock	Highway	Whipple truss	Wood	1869	72 5	2	7 8	6
3	Waldruff's	Highway	Whipple truss	Wood	1869	73 0	2	7 8	6
4	Glasgow street, Clyde	Highway	Whipple arch	Cast iron	1855	75 7	2	8 7	6
5	Sodus street, Clyde	Highway	Whipple arch	Cast iron	1855	79 8	2	9 1½	9
6	Sigman's	Farm	Whipple truss	Wood	1868	71 6	2	7 4	6
7	Barker's	Farm	Whipple truss	Wood	1868	71 2	2	7 8	6
8	Long's	Farm	Whipple truss	Wood	1875	70 7	2	7 10	6
9	Lock Berlin	Highway	Whipple truss	Wood		71 4	2	7 7	6
10	Horton's	Highway	Whipple truss	Wood		71 4	2	7 7½	6
11	Goetzman's	Farm	Whipple truss	Wood	1867	71 2	2	7 2	6
12	Klaus'	Highway	Whipple truss	Wood		73 2	2	7 7½	6
13	Richmonds'	Farm	Whipple truss	Wood		73 11	2	7 6	6
14	Cole's	Highway	Whipple truss	Wood		73 5	2	7 6	6
15	Geneva street, Lyons	Highway	Whipple arch	Cast iron	1856	84 0	2	9 6	9
16	Church street, Lyons	Highway	Whipple arch	Cast iron	1855	99 4½	2	11 6	9
17	Water street, Lyons	Highway	Whipple arch	Cast iron	1856	86 6	2	10 4½	9
18	Leach's, Lyons	Highway	Whipple arch	Cast iron	1872	73 5	2	9 1½	7
19	Prine's	Farm	Whipple truss	Wood		71 5	2	7 2½	6
20	Parks'	Highway	Plank truss	Wood	1848	72 0	2	6 2	4
21	Mosher's	Highway	Whipple truss	Wood		71 0	2	7 7	6
22	Change	Change	Whipple truss	Wood		71 10	2	7 2¾	6
23	Lockville	Highway	Whipple arch	Cast iron	1873	99 5	2	11 8	9
24	Charles street, Newark	Highway	Whipple arch	Cast iron	1856	73 10	2	8 3	7
25	Main street, Newark	Highway	Whipple arch	Cast iron	1856	78 5½	2	9 10	9
26	Allerton's	Highway	Whipple truss	Wood		71 3	2	7 7	6
27	Peek's	Highway	Whipple truss	Wood		71 4	2	7 6½	6
28	Sweezy's	Farm	Whipple truss	Wood		72 5	2	7 8	6
29	Palmer's	Highway	Whipple truss	Wood		71 4	2	7 7	6
30	Port Gibson	Highway	Whipple arch	Cast iron	1859	87 0	2	9 8	9
31	Galloway	Highway	Whipple truss	Wood		72 4	2	7 4	6
32	Railroad avenue, Palmyra	Highway	Whipple arch	Cast iron	1870	96 0	3	10 11	9
33	Market street, Palmyra	Highway	Whipple arch	Cast iron	1870	80 1	2	9 9	7
34	Church street, Palmyra	Highway	Whipple arch	Cast iron	1857	80 11	2	9 9½	9
35	Change	Change	Whipple truss	Wood		71 10	2	7 8½	6
36	Crandall's	Highway	Whipple truss	Wood	1856	71 10	2	7 8	6
37	Clark's	Farm	Whipple truss	Wood		72 7½	2	7 8½	6
38	White's	Highway	Whipple truss	Wood		70 11½	2	7 7¾	6

39.....	Change.....	High'y & change	Whipple truss . .	Wood.....	1870.....	73	0½	3	7	10	6
40.....	Macedon	Highway	Whipple arch.....	Cast iron.....	1860.....	72	3½	2	8	1	9
41.....	Freyer's.....	Highway	Whipple truss	Wood	.....	72	3	2	7	10	6
42.....	Wayneport.....	Highway	Whipple truss ..	Wood	1857.....	70	2	2	7	10	6
	SECTION IX.										
43.....	Knapp's.....	Highway	Whipple truss	Wood.....	1874.....	72	8½	2	7	10	6
44.....	Baker's.....	Highway	Whipple truss	Wood and iron	1864.....	72	10	2	7	10	6
45.....	Parker's.....	Highway	Whipple truss ...	Wood and iron	1868.....	80	4	2	8	0	7
46.....	Main street, Fairport.....	Highway	Whipple arch.....	Cast iron.....	1856.....	84	7	2	11	1	9
47.....	Fullam's basin.....	Highway	Whipple truss	Wood.....	1875.....	76	0	2	7	11	6
48.....	Wapping.....	Highway	Whipple truss ...	Wood and iron	1877.....	83	7	2	9	6	8
49.....	Wiltsie.....	Highway	Whipple truss	Wood	1873.....	74	11	2	7	11	6
50.....	Bushnell's basin.....	Highway	Whipple arch.....	Cast iron.....	1856.....	83	11	2	11	12	9
51.....	Cartersville.....	Highway	Whipple truss	Wood	1873.....	75	3	2	7	10¾	6
52.....	Guernsey's, Pittsford.....	Highway	Whipple truss ...	Wood and iron	1875.....	99	9	2	13	6¾	8
53.....	Pittsford, Pittsford..	Highway	Whipple arch.....	Cast iron	1870.....	83	8	2	11	4	9
54.....	Main street, Pittsford.....	Highway	Whipple arch.....	Cast iron..	1856.....	77	11	2	10	0	9
55.....	Sutherland's.....	Highway	Whipple truss	Wood and iron	1863.....	84	8	2	8	9	7
56.....	Cook's	Highway	Whipple truss	Wood and iron	1877.....	74	8	2	9	6½	7
57.....	Weed's.....	Highway	Whipple truss	Wood	1869.....	74	7	2	7	9	6
58.....	Billinghurst's.....	Highway	Whipple arch.....	Cast iron....	1867.....	74	0	2	8	9	7
59.....	Donelly's...	Highway	Whipple truss	Wood.....	1876.....	73	6	2	9	0	6
60.....	Drake's	Highway	Whipple truss ...	Wood and iron.....	1876.....	73	0	2	9	5	7
61.....	Brighton	Highway	Whipple arch.....	Cast iron...	1857.....	76	3½	2	8	5½	7
62.....	Culver street, Rochester..	Highway	Whipple truss	Wood and iron	1877.....	80	0	2	16	3½	6
63.....	Monroe street, Rochester.....	Highway	Whipple truss	Cast iron	1856. ...	111	11	2	16	3½	12
64.....	Goodman street, Rochester.....	Highway	Whipple arch.....	Cast iron.....	1875.....	91	1	2	12	8	9
65.....	Nelson street, Rochester	Highway	Cooper arch.....	Wrought iron... ...	1873.....	91	1	2	11	8	8
66.....	Averill street, Rochester	Highway	Whipple arch.....	Cast iron.....	1875.....	84	11	2	9	1½	9
67.. ..	Alexander street, Rochester.....	Highway	Whipple arch.....	Cast iron..... ...	1856.....	74	2	2	9	2	9
68.....	St. Paul street, Rochester	Highway	Leighton truss.. ..	Wrought iron.....	1875... .	118	6	3	19	7	9
69... ..	Griffith street, Rochester.....	Highway	Whipple truss	Cast iron	1869... .	108	1	2	8	9	9
70 A....	Weigh-lock, Rochester.....	Change	Whipple truss	Cast iron...	1858. .	81	9	2	6	3	8
70 B....	Weigh-lock, Rochester	Change	Whipple truss	Cast iron....	1858 .. .	49	9	2	6	4	5
71.....	Court street, Rochester.....	Highway	Whipple arch. ...	Cast iron.....	1856. ...	75	8	3	9	2½	9
72.....	Child's step, Rochester	Tow-path.....	Swing truss.....	Wrought iron.....	1872.....	83	0	2	4	0	2
73.....	Exchange street, Rochester.....	Highway	Swing truss.....	Wrought iron.....	1869.....	83	6	2	5	4	11
74 A....	Fitzhugh street, Rochester.....	Highway	Whipple arch.....	Cast iron	1859.....	86	7	2	9	2½	9
74 B....	Fitzhugh street, Rochester.....	Sidewalk	Whipple pipe truss	Cast iron	1859.....	86	7	2	5	9	9
75.....	Plymouth avenue, Rochester	Highway	Whipple arch.....	Cast iron.....	1857.....	84	8	3	9	10	9
76.....	Washington street, Rochester.....	Highway	Bollman truss.....	Cast iron.....	1855.....	85	6	2	14	3	6
77.....	West avenue, Rochester.....	Highway	Swing truss.....	Wrought iron.....	1875.....	82	9	2	4	4	11
78.....	Ford street, Rochester.....	Highway	Bollman truss.....	Cast iron	1855. ...	95	8	2	14	3	6
79.. ..	Genesee Valley canal, Rochester.....	Tow-path.....	Whipple pipe truss	Cast iron.....	1873.....	91	0	2	7	0	9
80... ..	Allen street, Rochester...	Highway	Whipple arch....	Cast iron.....	1851.....	81	7	2	9	3½	9
81.....	Brown street, Rochester.....	Highway	Whipple arch....	Cast iron.....	1859.....	77	8	2	8	4	9
82.. ..	Jay street, Rochester...	Highway	Whipple arch.....	Cast iron	1859. . .	84	2	2	9	0	9
83.....	Smith street, Rochester	Highway	Whipple arch.....	Cast iron...	1873.....	92	10	2	12	5	9
84.....	Lyell street, Rochester	Highway	Whipple arch....	Cast iron.....	1855.....	90	8	3	10	2	9
85.....	Emerson street, Rochester	Highway	Bollman truss.....	Cast iron.....	1875.....	106	10½	2	14	3½	10

Table of State bridges, etc. — (Continued).

Number.	NAME.	Class.	Plan.	Material.	Date of erection.	Clear span. ft. in.	Trusses. Number.	Trusses. Hight. ft. in.	Trusses. Number of panels.
86.....	Rome street, Rochester.....	Highway.....	Whipple arch.....	Cast iron.....	1873.....	95 5	2	11 5⅛	9
87.....	Change..	Change.....	Whipple truss	Wood.....	1866.....	82 7	2	7 7¼	6
88.....	Scott's.....	Highway	Whipple truss	Wood and iron.....	1877.....	82 1½	2	16 3⅜	6
89.....	Four Mile.....	Highway.....	Whipple truss	Wood.	1868.....	81 2	2	7 7¼	6
90.....	Speer's	Highway.....	Whipple truss	Wood and iron.....	1876.....	81 2	2	9 6⅝	8
91. ..	Six Mile.....	Highway.....	Whipple truss	Wood.....	1875.....	93 2	2	9 0	8
92... .	Douglas'.	Farm.....	Whipple truss	Wood.....	1875.....	80 6	2	8 6	6
93.....	Finley.....	Highway...	Whipple truss	Wood and iron.....	1877.. ..	83 8	2	16 3¾	6
94. ..	South Greece.....	Highway..... ..	Whipple truss	Wood and iron.....	1863.....	92 1	2	8 10	9
95.....	Cromwell's.....	Highway.....	Whipple truss	Wood.....	1875.....	81 10	2	9 0	6
96.....	Hiscock's.....	Highway.....	Whipple truss	Wood.....	1870.....	81 0	2	7 9	6
97.....	Norman's.....	Farm.....	Whipple truss	Wood.....	1875.....	81 8¾	2	8 11	6
98.....	Union street, Spencerport ..,.....	Highway.....	Whipple arch.....	Cast iron.....	1857.....	86 5	2	9 7	9
99.....	Amity street, Spencerport...	Highway.... ..	Whipple arch.....	Cast iron.....	1873....	94 8⅜	2	11 4½	9
100.....	Webster's, East....	Highway.....	Whipple truss ...	Wood.....	1872.....	83 2	2	10 0	7
101....	Webster's, West.....	Highway.....	Whipple truss	Wood	1873.....	82 11½	2	10 0	7
102.....	Crissey's.....	Highway.....	do trapezoidal do.	Cast iron..... ...	1876....	81 2	2	16 0	9
103.....	Adams' basin...	Highway	Whipple arch.....	Cast iron.....	1858.....	82 4	2	10 5	9
104.....	Doty's.....	Highway.....	Whipple truss	Wood and iron.....	1876....	83 7	2	9 11⅜	7
105.. ..	Brockway's..... ...	Highway.....	Whipple truss	Wood.....	1867.....	82 9	2	9 10	7
106.....	Cooley's basin.....	Highway.....	Whipple truss	Wood.....	1873	82 4	2	9 11	7
107.....	Mechanic street, Brockport.....	Highway.....	Whipple arch.....	Cast iron.....	1859.....	84 8	3	9 2	9
108.....	Main street, Brockport.....	Highway.....	Whipple arch....	Cast iron.....	1859.....	80 8	2	9 6	9
109.....	Smith street, Brockport	Highway.....	Whipple arch.....	Cast iron.....	1870.....	84 10	2	9 11½	9
	SECTION X.								
110.....	Danforth's.....	Highway.....	Whipple truss	Wood.....	1870.....	91 3	2	9 10	7
111.....	Miner's Town Line.....	Highway.....	Whipple arch.....	Cast iron.....	1871.....	86 5	2	10 1⅜	9
112.. ..	County Line.....	Highway.....	Whipple truss	Wood...	1871.....	91 4	2	9 9	8
113.....	Orr's	Highway.....	Whipple truss	Wood.....	1870....	87 4	2	9 10	7
114....	Frisbie's (old canal), Holley	Highway.....	Whipple arch....	Cast iron.....	1849.....	80 0	2	9 4	9
115.....	Holley, Holley.....	Highway.....	Whipple arch.....	Cast iron.....	1857.....	87 10	2	9 6⅜	9
116.....	McCarty's.	Highway.....	Whipple arch.....	Cast iron.....	1871.....	87 2	2	10 0⅜	9
117.....	Tuttle's.....	Highway.....	Whipple truss	Wood....	1872....	87 11⅜	2	9 11⅜	7
118. ...	McGuire's.....	Highway...	Whipple truss	Wood and iron.....	1876.....	88 0	2	9 9⅜	8
119.....	Hulburton	Highway.....	Whipple arch.....	Cast iron.....	1856....	91 5	2	10 5⅜	9
120.....	Brockville	Highway.....	Whipple arch.....	Cast iron.....	1871.....	92 9	2	10 0⅜	9
121.....	Hindsburgh	Highway	Whipple arch.....	Cast iron.....	1856.....	91 8	2	10 4	9

122	Transit	Highway	Whipple truss	Wood	1870	88 7⅓	2	9 1	7		
123	Jaqueth's	Highway	Whipple truss	Wood and iron	1876	90 6	2	10 7	8		
124	Bidwell's	Highway	Whipple truss	Wood	1870	89 6	2	9 11	8		
125	Brailey's	Highway	Whipple truss	Wood	1870	90 0	2	9 10⅓	8		
126	Hall's	Highway	Whipple arch	Cast iron	1856	91 0	2	10 4	9		
127	Ingersoll street, Albion	Highway	Bollman truss	Cast iron	1855	94 3	2	14 8	6		
128	Batavia street, Albion	Highway	Swing truss	Wrought iron	1871	82 2	2	5 4	11		
129	Lattin's	Farm	Whipple truss	Wood	1870	107 6⅓	2	13 0	8		
130	Gaines' Basin	Highway	Whipple truss	Wood	1870	107 10	2	12 11	8		
131	Eagle Harbor	Highway	Whipple arch	Cast iron	1856	104 5	2	11 7	9		
132	Starkweather's	Farm	Whipple truss	Wood	1870	91 10	2	9 10	8		
133	Allen's	Highway	Whipple truss	Wood	1870	92 7	2	9 11	8		
134	Long's	Highway	Whipple truss	Wood	1870	102 1⅓	2	12 10	8		
135	Knowlesville	Highway	Whipple arch	Cast iron	1856	102 2	2	12 2⅓	9		
136	Beal's	Highway	Whipple truss	Wood	1872	91 5⅓	2	9 11	8		
137	Hastings	Highway	Whipple arch	Cast iron	1877	95 2	2	10 11⅓	9		
138	Holloway's	Highway	Whipple arch	Cast iron	1869	91 8	2	12 6	9		
139	Church street, Medina	Highway	Whipple arch	Cast iron	1850	95 3	2	10 9	9		
140	Shelby street, Medina	Highway	Whipple arch	Cast iron	1855	91 0	2	10 3	9		
141	Jackson's	Highway	Whipple truss	Wood	1875	95 1⅓	2	10 0	8		
142	Shelby Basin	Highway	Whipple truss	Wood	1875	107 0	2	9 11	8		
143	Town Line	Highway	Whipple truss	Wood	1877	91 10	2	9 10	8		
144	Vernon street, Middleport	Highway	Whipple truss	Wood		99 11	2	9 10⅓	8		
145	Main street, Middleport	Highway	Whipple arch	Cast iron	1856	99 9	2	11 4	9		
146	Williams'	Highway	Whipple truss	Wood		91 6	2	9 8⅓	8		
147	Watson's	Highway	Whipple truss	Wood		91 2	2	9 10	8		
148	Hurd's	Highway	Whipple truss	Wood		98 5	2	9 10	8		
149	Reynales' Basin	Highway	Whipple truss	Wood		107 8	2	9 11	8		
150	Mabee's	Highway	Whipple arch	Cast iron	1871	100 8	2	12 7⅓	9		
151	Gasport	Highway	Whipple truss	Wood		98 6	2	8 8⅓	8		
152	Orangeport	Highway	Whipple arch	Cast iron	1871	99 1	2	12 5	9		
153	Millard's	Highway	Whipple arch	Cast iron	1857	98 1	2	11 5	9		
154	Wakeman's	Highway	Whipple truss	Wood		98 3	2	8 9	8		
155	Young's	Highway	Whipple arch	Cast iron	1857	99 5	2	11 3⅓	9		
156	Comstock's, Lockport	Highway	Whipple arch	Cast iron	1857	103 4	2	12 0	9		
157	Adams street, Lockport	Highway	Whipple arch	Cast iron	1859	103 0	2	11 2	9		
158	Chapel street, Lockport	Highway	Whipple arch	Cast iron	1855	81 3	2	9 2⅓	9		
159	Exchange street, Lockport	Highway	Bollman truss	Cast iron	1855	80 4⅓	2	14 4	6		
160	Cadye street, Lockport	Highway	Whipple truss	Wood and iron	1877	88 0	2	9 9⅓	8		
161 A	Pine street, Lockport	Highway	do trapezoidal do	Cast iron	1858	112 4⅓	3	11 6	10		
161 B	Pine street, Lockport	Highway	do trapezoidal do	Cast iron	1858	54 11	3	5 9	5		
162	Cottage street, Lockport	Highway	Roof truss	Wood	1863	84 8	4	12 0	.....		
163	Main street, Lockport	Highway	Roof truss	Wood		74 2	27	9 11⅓	.....		
164	Transit street, Lockport	Highway	Whipple arch	Cast iron	1872	114 0	2	15 3	11		
165	Hitchins	Highway	Whipple arch	Cast iron	1870	74 2	2	9 0	7		
166 A	Heacox	Highway	Whipple truss	Wood	1876	42 8	2	6 9	4		
166 B			Whipple arch	Cast iron	1856	99 4	2	11 11	9		
166 C			Whipple truss	Wood	1876	47 8	2	6 9	9		
167 A	Hawley	Highway	Whipple truss	Wood	1876	37 0	2	5 4	4		
167 B			Whipple truss	Cast iron	1856	100 8	2	12 9	4		
167 C			Whipple truss	Wood	1876	37 0	2	5 4	8		

Table of State bridges, etc. — (Continued).

Number.	NAME.	Class.	Plan.	Material.	Date of erection.	Clear span. ft. in	Trusses. Number.	Trusses. Hight. ft. in.	Trusses. Number of panels.
168. A	Sulphur Spring guard-lock	Highway	Whipple truss	Wood	1874	46 9	2	6 0¼	4
168. B		Highway	Whipple truss	Wood	1874	34 4	2	6 1⅛	4
168. C		Highway	Whipple truss	Wood	1874	37 8	2	6 1	4
	SECTION XI.								
169 A	Pendleton	Highway	Whip. trapezoidal.	Cast iron	1854	102 0	2	11 6	10
169 B	Pendleton	Change	Whipple pipe truss	Cast iron	1854	102 0	1	7 1	10
170	Old Canal Pendleton	Highway	Whipple pipe truss	Wood	1873	50 4	2	7 0	8
171	Tonawanda creek (3 spans)	Towpath	Whipple pipe truss	Wood and iron	1877	W 61 2	2	8 3½	6
172	Ransom's creek	Towpath	Howe truss	Wood	1876	33 4	2	5 8⅛	8
173	New Home (2 spans)	Highway	Whipple truss	Wood and iron	1865	94 1	2	8 8	8
174 A	Pickard's	Highway	Whipple truss	Wood and iron	1865	107 5	2	9 11	8
174 B		Highway	Whipple truss	Wood and iron	1865	66 8	2	7 8	6
174 C		Highway	Whipple truss	Wood	1865	31 6	2	6 7	3
175	Bush's	Highway	Bowstring	Wrought iron	1873	171 1	2	21 1	14
176	Ellicott creek	Towpath	Swartz lift	Wrought iron	1868	27 4	2	4 7	6
177	Main street, Tonawanda	Highway	Whipple arch	Cast iron	1864	85 8	2	9 8	9
178	River lock slip, Tonawanda	Highway	Whipple arch	Cast iron	1871	52 2	2	6 6	5
179	Seymour street, Tonawanda	Highway	Whipple arch	Cast iron	1857	84 0	2	9 0¾	9
180	Bouck street, Tonawanda	Highway	Bollman truss	Cast iron	1855	83 10	2	14 7	6
181	Change street, Tonawanda	Change	Whipple pipe truss	Cast iron	1857	95 7	2	8 0⅛	9
182	Grand Island ferry, Tonawanda	Highway	Whipple arch	Cast iron	1874	95 7	2	11 7⅛	9
183	Three mile	Farm	Whipple truss	Wood		84 8	2	9 11	6
184	Cherry's	Farm	Whipple truss	Wood		83 8	2	9 11	6
185	Lineberg's	Farm	Whipple truss	Wood		82 11	2	9 11	6
186	Scott's (Grand Island ferry)	Highway	Whipple truss	Wood		81 10	2	9 11	6
187	Change, Black Rock	Change	Whipple pipe truss	Cast iron	1856	93 8	2	8 0¾	9
188	Pratt's slip, Black Rock	Towpath	Swartz lift	Wrought iron	1873	21 10	2	3 4	4
189	Bird street, Black Rock	Highway	Whipple arch	Cast iron		104 1	2	12 1	9
190	Hamilton street, Black Rock	High'y & change	Cooper arch	Wrought iron	1873	108 0	2	11 9	10
191	Amherst street, Black Rock	Highway	Whipple arch	Cast iron	1857	117 3	2	14 8⅛	11
192	Mill street, Black Rock	Highway	Whipple truss	Wood	1873	113 0¾	2	9 1	9
193	Scajaquada creek	Towpath	Arch draw	Wood	1876	41 6	2	7 2	16
194	Ferry street, Buffalo	Highway	Lattice riveted	Wrought iron	1875	135 5	2	16 0	13
195	Ferry street, Buffalo	Highway	Plategirder swing	Wrought iron	1869	118 2	2	5 0	
196. A	York street, Buffalo	High'y & change	Whipple truss	Wood and iron	1875	85 8¼	2	8 11	8
196. B	York street, Buffalo	High'y & change	Whipple truss	Wood and iron	1867	84 6	2	8 9	8
197	Georgia street, Buffalo	Highway	Whipple arch	Cast iron	1871	178 1	2	20 0	15
198	Slip No. 3, Buffalo	Towpath	Whipple truss	Wood		59 0	2	6 5	6
199	Wilkinson's, Buffalo	Towpath	Arch draw	Wood		25 2	2	6 0	5

200	Genesee street (2 spans), Buffalo	Highway	Whipple arch	Cast iron	1857	S 84 0 N 83 2	3	10 0	9
201	Slip No. 2, Buffalo	Towpath	Whipple truss	Wood	1866	59 10	2	6 6	6
202	Slip No. 1, Buffalo	Towpath	Whipple truss	Wood	1862	86 0	2	6 10	8
203 A	Erie street, Buffalo	Sidewalk	Whipple pipe truss	Cast iron	1868	100 0	1	5 6	10
203 B		Highway	Whipple arch	Cast iron	1868	90 9	4	10 8⅛	9
203 C		Sidewalk	Whipple pipe truss	Cast iron	1868	91 6	1	5 6	9
204	Commercial street, Buffalo	Highway	Swartz arch	Cast iron	1859	88 10	3	12 0	8
205	Canal street Com. slip, Buffalo	Highway	Whipple arch	Cast iron	1849	85 10	3	9 9⅛	9
206	Prime street Com. slip, Buffalo	Highway	Whipple arch	Cast iron	1849	87 0	3	10 5⅛	9
207	Lloyd street, Buffalo	Highway	Swartz arch	Cast iron	1867	88 6	3	11 11⅛	8
208 A	Main street, Buffalo	Highway	Whipple arch	Cast iron	1867	72 0	4	8 8⅛	7
208 B		Sidewalk	Whipple pipe truss	Cast iron	1867	72 0	2	5 6	7
209 A	Washington street H. C., Buffalo	Sidewalk	Latten riveted truss	Wrought iron	1873	.....	2	5 0	18
209 B		Highway	Latten riveted truss	Wrought iron	1873	91 2	2	9 0	9
209 C		Highway	Latten riveted truss	Wrought iron	1873	.....	1	10 0	9
210	Scott street, Clark & Skinner Canal, Buffalo	Highway	Whipple arch	Cast iron	1869	81 0	2	9 6¾	9
211	Perry street, Clark & Skinner Canal, Buffalo	Highway	Whipple arch	Cast iron	1855	65 0	3	8 0⅛	7
212	Elk street, Clark & Skinner Canal, Buffalo	Highway	Bollman truss	Cast iron	1868	55 5	3	6 4	4
213	Ohio street, Clark & Skinner Canal, Buffalo	Highway	Bollman truss	Cast iron	1868	58 0	3	6 4	4
214 A	Michigan street, Hamburgh C., Buffalo	Highway	Whipple arch	Cast iron	1864	89 6	3	10 3⅛	9
214 B		Sidewalk	Whipple pipe truss	Cast iron	1864	.....	2	5 3	9
215	Chicago street, Hamburgh C., Buffalo	Highway	Whipple arch	Cast iron	1851	89 6	3	10 4	9
216	Louisiana street, Hamburgh C., Buffalo	Highway	Swartz arch	Cast iron	1862	90 3	3	11 8	8
217	Perry street, Ohio slip, Buffalo	Highway	Whipple arch	Cast iron	1858	59 0	3	7 5	7
218	Fulton street, Ohio slip, Buffalo	Highway	Whipple arch	Cast iron	1871	61 9	2	7 2⅛	7
219	Elk street, Ohio slip, Buffalo	Highway	Britton arch	Cast iron	1864	59 5	3	7 0	6
220	Ohio street, Ohio slip, Buffalo	Highway	Swing	Wrought iron	1873	41 6	2	6 5⅛	8

Table of State bridges, etc. — (Continued).

Number.	NAME.	Width on Centres.				Skew.		Floor Beams.			
		Roadway.		Sidewalks.				No.	Material.	Size.	
		No.	Ft. In.	No.	Ft. In.	Deg. Min.				No.	Width. Depth.
	SECTION VIII.										
1	Wayne County Line	1	17 3		None	None		5	Pine		9 x 14
2	Pit lock	1	17 3		None	None		5	Pine		9 x 14
3	Waldruff's	1	17 3		None	None		5	Pine		9 x 13½
4	Glasgow street, Clyde	1	18 11	2	6 4	9 deg. 28 min. R.		8	Wrought iron I		6 x 9¾
5	Sodus street, Clyde	1	19 1	2	6 0	22 deg. 0 min. R.		9	Wrought iron I		6 x 10
6	Sigman's	1	12 1		None	None		5	Pine		9 x 12
7	Barker's	1	12 3		None	None		5	Pine		8½ x 12
8	Long's	1	12 2		None	None		5	Pine		9 x 12
9	Lock, Berlin	1	17 1		None	None		5	Pine		9 x 14
10	Horton's	1	17 3		None	None		5	Pine		9 x 14
11	Goetzman's	1	12 1		None	None		5	Pine		9 x 12
12	Klaus'	1	16 8		None	None		5	Oak		9 x 14
13	Richmond's	1	12 0		None	None		5	Oak		9 x 12
14	Cole's	1	17 3		None	None		5	Pine		9 x 14
15	Geneva street, Lyons	1	19 1	2	6 0	16 deg. 5 min. R.			Wrought iron I		6 x 9¾
16	Church street, Lyons	1	19 1	2	7 0	34 deg. 55 min. L.			Wrought iron I		6 x 10
17	Water street, Lyons	1	19 1	2	6 0	25 deg. 15 min. L.			Wrought iron I		6 x 10
18	Leach's	1	17 1		None	None		6	Wrought iron I		4½ x 10
19	Prine's	1	12 2		None	None		5	Oak		12 x 9
20	Parks'	1	19 8		None	None		3	Pine		8½ x 14
21	Mosher's	1	17 2		None	None		5	Pine		9 x 14
22	Change	1	12 0		None	None		5	Pine		9 x 12
23	Lockville	1	19 3		None	1 deg. 35 min. L.		8	Wrought iron I		4½ x 10½
24	Charles street, Newark	1	19 0		None	6 deg. 30 min. R.		6	Wrought iron I		6 x 10
25	Main street, Newark	1	19 1	2	6 0	None		8	Wrought iron I		6 x 10
26	Allerton's	1	17 2		None	None		5	Pine		9 x 14
27	Peek's	1	18 0		None	None		5	Pine		9 x 13½
28	Sweezy's	1	17 2		None	None		5	Pine		9 x 14
29	Palmer's	1	17 1		None	None		5	Pine		9 x 12
30	Port Gibson	1	19 2		None	None		8	Wrought iron I		6 x 10
31	Galloway	1	15 6		None	None		5	Pine		10 x 12
32	Railroad avenue, Palmyra	2	18 3–18 6	1	6 0	32 deg. 15 min. R.		9	Wrought iron I		4½ x 10½
33	Market street, Palmyra	1	18 0	1	6 0	4 deg. 55 min. L.		6	Wrought iron I		4½ x 10½
34	Church street, Palmyra	1	19 4		None	None		8	Wrought iron I		6 x 10
35	Change	1	12 3		None	None		5	Pine		9 x 12
36	Crandall's	1	17 0		None	None		5	Oak		10 x 12
37	Clark's	1	12 1¼		None	None		5	Pine		8 x 12
38	White's	1	17 0		None	None		5	Pine		10 x 12

39	Change	2	17	3-19	0		None	None	5	Oak		8½ x 12
40	Macedon	1		17	3		None	None	8	Wrought iron I		6 x 10
41	Freyer's	1		17	0		None	None	5	Oak		10 x 12
42	Wayneport	1		17	6		None	None	5	Oak		10 x 12
	SECTION IX.											
43	Knapp's	1		17	0		None	None	5	Oak		8½ x 12
44	Baker's	1		18	10		None	None	5	Oak		9 x 14
45	Parker's	1		17	0		None	None	6	Oak		8½ x 14
46	Main street, Fairport	1		19	2	2	6 0	32 deg. 00 min. L.		Oak	2	4 x 14
47	Fullam's basin	1		17	1		None	13 deg. 30 min. R.	5	Oak		8½ x 12
48	Wapping	1		17	6		None	27 deg. 45 min. L.	8	Wrought iron] [	2	2½ x 10
49	Wiltsie	1		17	3		None	10 deg. 30 min. L.	5	Pine		9 x 12
50	Bushnell's basin	1		19	1¼	2	6 0	30 deg. 30 min. L.		Oak	2	4 x 12
51	Cartersville	1		15	1¼		None	None	5	Oak		9 x 12
52	Guernsey's, Pittsford	1		17	1		None	10 deg. 35 min. R.	7	Oak		9 x 14
53	Pittsford, Pittsford	1		19	1		None	33 deg. 00 min. R.		Oak	2	4 x 11½
54	Main street, Pittsford	1		19	1	2	5 0	24 deg. 20 min. L.		Oak	2	4 x 12½
55	Sutherland's	1		17	2		None	31 deg. 45 min. L.	6	Pine		9 x 14
56	Cook's	1		14	8		None	12 deg. 45 min. R.	6	Oak		10 x 12
57	Weed's	1		17	1½		None	None	5	Oak		9 x 12
58	Billinghurst's	1		18	3		None	None	6	Wrought iron I		4½ x 10½
59	Donnelly's	1		17	3		None	2 deg. 10 min. L.	5	Oak		10 x 11½
60	Drake's	1		18	1		None	2 deg. 10 min. L.	6	Oak		9½ x 12
61	Brighton	1		19	0		None	15 deg. 30 min. R.	6	Oak	2	4 x 11½
62	Culver street, Rochester	1		15	4		None	None	5	Oak		10 x 12
63	Monroe street, Rochester	1		19	1½		None	45 deg. 00 min. L.	13	Oak	2	5 x 12
64	Goodman street, Rochester	1		17	5	2	6 0	18 deg. 0 min. R.	8	Wrought iron I		4½ x 10½
65	Nelson street, Rochester	1		19	0	2	6 0	10 deg. 10 min. L.	7	Wrought iron I		4½ x 10½
66	Averill street, Rochester	1		18	2	2	6 0	None	8	Wrought iron I		4½ x 10½
67	Alexander street, Rochester	1		19	0	2	6 0	None	8	Oak	2	4 x 13½
68	St. Paul street, Rochester	2		18	1½	2	8 0	50 deg. 45 min. L.	12	Plate iron I		6½ x 15
69	Griffith street, Rochester	1		16	9		None	23 deg. 52 min. R.	8	Oak	2	4½ x 14
70 A	Weigh-lock, Rochester	1		18	6		None	None	7	Oak	2	4 x 9½
70 B	Weigh-lock, Rochester	1		12	0		None	None	4	Oak	2	4 x 10
71	Court street, Rochester	2		13	8	2	7 6	3 deg. 45 min. L.	8	Oak	2	3½ x 13½
72	Child's slip, Rochester	1		11	5½		None	None	0			
73	Exchange street, Rochester	1		18	0	2	5 4	None	11	Plate iron		6 5-16 x 14
74 A	Fitzhugh street, Rochester	1		18	1¼			7 deg. 12 min. L.	8	Cast iron		6 x 10½
74 B	Fitzhugh street, Rochester					2	9 1	7 deg. 12 min. L.	8	Cast iron		5¾ x 8½
75	Plymouth avenue, Rochester	2		15	0	2	7 2	12 deg. 45 min. L.	8	Oak	2	4 x 11
76	Washington street, Rochester	1		21	3	2	9 2	17 deg. 15 min. L.	5	Wrought iron I		4½ x 10½
77	West avenue, Rochester	1		18	0	2	6 6	None	10	Plate iron I		6 5-16 x 14
78	Ford street, Rochester	1		15	6	2	5 4	26 deg. 30 min. L.	5	Wrought iron] [	2	2½ x 9
79	Genesee Valley canal, Rochester	1		14	10		None	None	8	Wrought iron I		3⅞ x 9
80	Allen street, Rochester	1		16	4	2	5 6	1 deg. 45 min. R.	8	Cast iron		4 x 18
81	Brown street, Rochester	1		20	1½	2	6 2½	24 deg. 15 min. L.	8	Oak	2	5 x 13
82	Jay street, Rochester	1		20	3	2	6 6	10 deg. 30 min. L.	8	Oak	2	3¾ x 13
83	Smith street, Rochester	1		16	0	2	5 0	18 deg. 30 min. R.	8	Wrought iron I		4 x 9½
84	Lyell street, Rochester	1		18	6	2	6 6	30 deg. 15 min. R.	8	Oak	2	4 x 13½
85	Emerson street, Rochester	1		18	0	2	6 3	23 deg. 0 min. R.	9	Wrought iron I		4½ x 10½

Total of State bridges, etc. — (Continued).

Number.	NAME.	Width on Centers.				Skew.		Floor Beams.				
		Roadway.		Sidewalks.				No.	Material.	Size.		
		No.	Ft. In.	No.	Ft. In.	Deg.	Min.			No.	Width.	Depth.
86	Rome street, Rochester	1	18 10		None	3 deg.	04 min. R.	8	Wrought iron I		4	x 10
87	Change	1	11 4		None	3 deg.	04 min. R.	5	Oak		8	x 9½
88	Scott's	1	15 4		None	18 deg.	45 min. L.	5	Oak		10	x 12
89	Four Mile	1	17 0		None	15 deg.	35 min. R.	5	Oak	6	9	x 12
90	Speer's	1	17 0		None	10 deg.	30 min. R.	7	Oak		10	x 12
91	Six Mile	1	16 9		None	29 deg.	15 min. L.	7	Oak		12	x 12
92	Douglas'	1	18 4		None	None		5	Oak		9	x 12
93	Finley's	1	15 4		None	18 deg.	45 min. R.	5	Oak		12	x 12
94	South Greece	1	19 0		None	28 deg.	40 min. L.	7	Pine		9	x 14
95	Cromwell's	1	17 3		None	None		5	Oak		9	x 12
96	Hiscock's	1	16 0		None	None		5	Oak		9	x 12
97	Norman's	1	18 3		None	None		5	Oak		8¾	x 12
98	Union street, Spencerport	1	19 0	2	5 7	11 deg.	30 min. L.	8	Oak	2	4	x 14
99	Amity street, Spencerport	1	18 6		None	21 deg.	10 min. L.	8	Wrought iron I		4½	x 10
100	Webster's east	1	15 3		None	None		6	Oak		9	x 14
101	Websters' west	1	18 0		None	None		6	Oak		9⅜	x 11½
102	Crissey's	1	19 6		None	3 deg.	30 min. L.	8	Wrought iron I		6	x 10
103	Adams' basin	1	18 0	2	5 8	5 deg.	45 min. L.	8	Oak	2	4	x 14
104	Doty's	1	17 2		None	None		6	Oak		10	x 12
105	Brockway's	1	14 7		None	None		6	Oak		12	x 12
106	Cooley's basin	1	17 3		None	None		6	Oak		8	x 12
107	Mechanics street, Brockport	1	18 4	2	6 1	11 deg.	30 min. L.	8	Oak	2	4½	x 13
108	Main street, Brockport	2	12 1	2	6 1	10 deg.	0 min. L.	8	Wrought iron I		3⅞	x 9
109	Smith, street Brockport	1	18 0	2	6 0	None		8	Wrought iron I		6⅛	x 10
	Section X.											
110	Danforth's	1	15 3		None	None		6	Oak		12	x 12
111	Miner's, town line	1	18 0		None	None		8	Wrought iron I		6	x 10
112	County line	1	14 6		None	19 deg.	15 min. L.	7	Oak		8	x 10
113	Orri's	1	13 6		None	None		6	Oak		8	x 10
114	Frisbie's (old canal) Holley	1	18 0	2	5 3	9 deg.	30 min. L.	8	Pine	2	4	x 10
115	Holley, Holley	1	19 0		None	None		8	Oak	2	4¼	x 12
116	McCarty's	1	18 0		None	8 deg.	30 min. L.	8	Wrought iron I		6	x 10
117	Tuttle's	1	15 3		None	None		6	Oak		9	x 10
118	McGuire's	1	15 0		None	None		7	Oak		12	x 12
119	Hulburton	1	18 10	2	5 8	13 deg.	06 min. R.	8	Oak	2	4	x 12
120	Brockville	1	16 9		None	16 deg.	45 min. L.	8	Wrought iron I		6	x 10
121	Hindsburgh	1	18 9	1	5 10	11 deg.	0 min. R.	8	Wrought iron I		6	x 10

122	Transit	1	15	8		None	3 deg. 0 min. R.	6	Oak		9	x	10
123	Jacqueth's	1	17	0		None	None	7	Oak		10	x	12
124	Bidwell's	1	15	2		None	None	7	Oak		9	x	10
125	Bradley's	1	14	11		None	None	7	Oak		9	x	10
126	Hall's	1	19	0		None	6 deg. 18 min. R.	8	Oak	2	4	x	11½
127	Ingersoll street, Albion	1	20	0	2	4 8	15 deg. 42 min. L.	5	Pine	2	7	x	13
128	Batavia street, Albion	1	17	0	2	5 0	None	9	Wrought iron		6¼	x	14
129	Lattin's	1	14	7		None	26 deg. 48 min. L.	7	Oak		12	x	13
130	Gaines' Basin	1	19	8		None	32 deg. 46 min. L.	8	Oak		12	x	12
131	Eagle Harbor	1	19	0	2	5 6	29 deg. 0 min. R.	9	Wrought iron I		4	x	10
132	Starkweather's	1	15	0		None	None	7	Oak		9	x	10
133	Allen's	1	15	5		None	8 deg. 18 min. R.	7	Oak		10	x	12
134	Long's	1	18	9		None	26 deg. 0 min. R.	8	Oak		9	x	10
135	Knowlesville	1	20	4	2	5 6	25 deg. 20 min. R.	8	Wrought iron I		4⅛	x	10¾
136	Beal's	1	14	11⅛		None	4 deg. 8 min. R.	7	Oak		8	x	9¾
137	Hastings	1	18	2		None	20 deg. 54 min. R.	8	Wrought iron I		4⅛	x	10⅜
138	Holloway's	1	19	0		None	None	8	Cast iron I		5⅛	x	16
139	Church street, Medina	1	17	6	2	5 2⅛	None	8	Oak	2	4¼	x	12
140	Shelby street, Medina	1	19	0	2	5 8⅛	None	8	Wrought iron I		6	x	10
141	Jackson's	1	17	2		None	15 deg. 42 min. R.	8	Oak		10	x	12
142	Shelby Basin	1	18	7⅛		None	14 deg. 32 min. R.	7	Oak		10	x	12
143	Town Line	1	18	11		None	None	7	Oak		9	x	12
144	Vernon street, Middleport	1	17	6		None	20 deg. 30 min. R.	7	Oak		10	x	12
145	Main street, Middleport	1	18	10	2	5 9⅛	23 deg. 8 min. R.	8	Oak	2	4	x	13
146	Williams'	1	15	7		None	None	7	Oak		11⅛	x	12
147	Watson's	1	17	2		None	7 deg. 14 min. R.	7	Oak		10	x	12
148	Hurd's	1	15	2		None	12 deg. 22 min. R.	7	Oak		12	x	12
149	Reynales' Basin	1	17	4		None	14 deg. 24 min. L.	7	Oak		9	x	12
150	Mabee's	1	19	0		None	3 deg. 22 min. R.	8	Wrought iron I		6	x	10
151	Gasport	1	17	8		None	10 deg. 42 min. R.	7	Oak		10	x	12
152	Orangeport	1	19	0	1	4 9⅛	18 deg. 6 min. R.	8	Wrought iron I		6	x	10
153	Millard's	1	19	0		None	1 deg. 56 min. R.	8	Wrought iron I		6	x	10
154	Wakeman's	1	18	7		None	2 deg. 54 min. L.	7	Oak		12	x	12⅜
155	Young's	1	19	0		None	None	8	Wrought iron		4	x	10
156	Comstock, Lockport	1	19	0	2	6 2	None	8	Wrought iron I		6	x	10
157	Adams street, Lockport	1	17	0		None	None	8	Wrought iron I		6	x	10
158	Chapel street, Lockport	1	17	0		None	None	8	Oak	2	4	x	12
159	Exchange street, Lockport	1	20	0	2	6 3	None	5	Wrought iron	2	2½	x	9
160	Cadys street, Lockport	1	15	0		None	None	7	Wrought iron		2⅜	x	10⅜
161 A	Pine street, Lockport	1	18	8	2	5 10	19 deg. 30 min. R.	9	Cast iron I		4¼	x	10
161 B	Pine street, Lockport	1	18	8	2	5 10	19 deg. 30 min. R.	4	Cast iron I		4¼	x	10
162	Cottage street, Lockport	1	17	6	2	9 0	9 deg. 30 min. R.	4	Oak		9	x	12
163	Main street, Lockport	1	257	10	2	6 6	None	4	Oak		9¾	x	12
164	Transit street, Lockport	1	19	0	2	5 4	41 deg. 0 min. R.	12	Wrought iron I		4	x	10½
165	Hitchens	1	18	0		None	None	6	Wrought iron I		4½	x	12
166 A		1	15	0		None	None	8	Oak		9	x	11½
166 B	Heacox	1	15	0		None	None	8	Oak	2	4⅛	x	13
166 C		1	15	0		None	None	8	Oak		9	x	11½
167 A		1	15	6⅜		None	None	8	Oak		9½	x	12
167 B	Hawley	1	15	1		None	None	7	Cast iron I		4	x	
167 C		1	15	6¼		None	None	8	Oak		9⅛	x	12

Total of State bridges, etc. — (Continued).

Number.	NAME.	Width on Centers. Roadways. No.	Roadways. Ft. In.	Sidewalks. No.	Sidewalks. Ft. In.	Skew. Deg. Min.	Floor Beams. No.	Material.	Size. No.	Size. Width. Depth.
168. A, B, C	Sulphur Spring guard-lock	1	11 1	.....	None	None	3	Oak	.....	8 x 12
		1	11 1	.....	None	None	3	Oak	.....	10 x 12
		1	11 1	.....	None	None	3	Oak	.....	8 x 12
	SECTION XI.									
169. A	Pendleton	1	13 0	....	None	None	9	Oak	.....	9½ x 11
169. B	Pendleton	1	9 2	.....	None	None	9	Cast iron I	.....	4½ x 11¾
170.	Old Canal Pendleton	1	17 2	.....	None	None	7	Oak	.....	11½ x 11½
171.	Tonawanda creek (3 spans)	1	11 0	.....	None	29 deg. 18 min. R.	6	Oak	....	10 x 6
172.	Ransom's creek	1	13 0	.....	None	None	3	Pine	.....	8 x 8
173.	New Home (2 spans)	1	18 2	.....	None	27 deg. 35 min. R.	7	Pine	.....	9 x 12
174. A	Pickard's	1	17 6	.....	None	None	7	Pine	.....	9 x 15
174. B		1	17 6	.....	None	None	5	Pine	....	10 x 15
174. C		1	17 6	.....	None	None	2	Pine	.....	9 x 13¾
175.	Bush's	1	18 8	.....	None	None	18	Wrought iron I	.....	4 x 10
176.	Ellicott creek	1	10 6	.....	None	None	0		.....	
177.	Main street, Tonawanda	1	19 3	2	6 6	12 deg. 0 min. R.	8	Wrought iron][	2	2½ x 10
178.	River lock slip, Tonawanda	1	18 8	.....	None	4 deg. 25 min. R.	4	Wrought iron I	.....	6 x 10½
179.	Seymour street, Tonawanda	1	18 8	2	6 5	None	8	Oak	2	5 x 15
180.	Bouck street, Tonawanda	1	18 8	2	6 3	None	5	Oak	2	5 x 14
181.	Change street, Tonawanda	1	14 8	.....	None	None	8	Cast iron I	.....	4½ x 14
182.	Grand Island ferry, Tonawanda	1	17 0	.....	None	None	3	Wrought iron][	2	2½ x 9
183.	Three mile	1	16 0	.....	None	None	5	Oak	.....	12 x 12
184.	Cherry's	1	15 7	.....	None	None	5	Pine	.....	12 x 12
185.	Lineberg's	1	12 8	.....	None	None	5	Pine	.....	11 x 12
186.	Scott's (Grand Island ferry)	1	14 0	.....	None	None	5	Pine	.....	12 x 12
187.	Change, Black Rock	1	17 6	.....	None	None	8	Oak	2	6 x 14
188.	Pratt's slip, Black Rock	1	10 4	.....	None	None	0		.....	
189.	Bird street, Black Rock	1	18 1	.....	None	None	8	Wrought iron I	.....	4½ x 12½
190.	Hamilton street, Black Rock	1	18 3	.....	None	None	9	Wrought iron I	....	3¾ x 9
191.	Amherst street, Black Rock	1	19 0	2	6 0	None	10	Wrought iron I	.....	4½ x 10½
192.	Mill street, Black Rock	1	13 2	.....	None	None	8	Oak	.....	12 x 12
193.	Scajaquada creek	1	12 0	.....	None	None	0		.....	
194.	Ferry street, Buffalo	1	18 0	1	6 0	None	12	Wrought iron I	.....	6¼ x 15
195.	Ferry street, Buffalo	1	16 9	....	None	None	11	Wrought iron I	.....	4 x 9½
196. A	York street, Buffalo	1	19 1	.....	None	None	7	Oak	.....	9 x 12
196. B	York street, Buffalo	1	19 1	.....	None	None	7	Oak	.....	10 x 12
197.	George street, Buffalo	1	20 0½	....	None	None	14	Wrought iron I	.....	6 x 10
198.	Slip No. 3, Buffalo	1	12 11	.....	None	None	5	Oak	.....	12 x 12
199.	Wilkinson's, Buffalo	1	11 0	.....	None	None	4	Pine	.....	9 x 9

200	Genesee street (2 spans), Buffalo	2		19	0	2		7	6	8 deg. 10 min. R.	8	Wrought iron I		6 x 10
201	Slip No. 2, Buffalo	1		13	0		None			None	5	Oak		9 x 12
202	Slip No. 1, Buffalo	1		15	8		None			18 deg. 50 min. L.	7	Oak		12 x 12
											9	Wrought iron I		4 x 9
203 A	Erie street, Buffalo	3		19	10	2		19	3	9 deg. 0 min. R.	8	Wrought iron I		5⅛ x 9
203 B											8	Wrought iron I		4 x 9
203 C											7	Wrought iron] [	2	2⅛ x 9
204	Commercial street, Buffalo	2		16	0	2		8	4	2 deg. 15 min. L.	8	Wrought iron] [	2	2⅛ x 9⅛
205	Canal street Com. slip, Buffalo	3	17	0–16	7¾	2	7	4⅛–7	8	4 deg. 25 min. R.	8	Wrought iron I		5¾ x 10
206	Prime street Com. slip, Buffalo	2	11	7–11	10	2	5	5 6	6	21 deg. 10 min. R.	7	Wrought iron] [	2	2⅛ x 9
207	Lloyd street, Buffalo	2	16	10–17	3	2		6	9	2 deg. 20 min. R.	6	Wrought iron I		5⅛ x 9
208 A	Main street, Buffalo	2		20	2	2		19	0	None	6	Wrought iron I		4 x 9
208 B										None	8	Wrought iron I		6¼ x 10
209 A	Washington street H. C., Buffalo	2		19	1	2		12	0	20 deg. 30 min. R.	8	Wrought iron I		6 x 12
209 B											3	Wrought iron I		6 x 12
209 C											8	Cast iron I		5 x 16
210	Scott street, Clark & Skinner Canal, Buffalo	1		19	0	2		7	1	None	6	Wrought iron I		6 x 10
211	Perry street, Clark & Skinner Canal, Buffalo	2		19	0	2		6	11	None	3	Oak	2	6 x 15
212	Elk street, Clark & Skinner Canal, Buffalo	2		20	0	2		8	0	None	3	Wrought iron I		4¼ x 10⅛
213	Ohio street, Clark & Skinner Canal, Buffalo	2		19	5	2		7	4	19 deg. 30 min. R.	8	Wrought iron I		6 x 10
214 A	Michigan street, Hamburgh C., Buffalo	2		18	2	2		12	4	None	8	Wrought iron I		6 x 10
214 B								7	4	None	8	Wrought iron I		4⅛ x 10⅛
215	Chicago street, Hamburgh C., Buffalo	2		19	1	2		7	0	None	7	Wrought iron] [	2	2⅛ x 9⅛
216	Louisiana street, Hamburgh C., Buffalo	2		16	11	2		7	0	None	6	Oak	2	5 x 14
217	Perry street, Ohio slip, Buffalo	2		16	1	2		7	0	None	6	Wrought iron I		6 x 10
218	Fulton street, Ohio slip, Buffalo	1		19	6	2		6	0	None	5	Wrought iron I		6 x 10
219	Elk street, Ohio slip, Buffalo	2	18	0–18	6	2		7	10	None	7	Wrought iron I		4¾ x 12⅛
220	Ohio street, Ohio slip, Buffalo	1		19	9¼		None			None				

GENESEE VALLEY CANAL.

The Genesee Valley canal, from its junction with the Erie at Rochester, to its terminus, near Mill Grove, on the Allegany river, is 113½ miles long; the Dansville Branch is eleven miles long; total, 124½ miles.

The principle sources of water supply are the Oil Creek reservoir, and the Ischua reservoir on the Summit level, the Rockville reservoir and the Genesee river, at Oramel and Mount Morris.

The Oil Creek reservoir has an area of about 800 acres embraced within the blue line. The dam is about 2,200 feet long and twenty feet wide on top. It is about sixty-five feet high where it crosses the channel, and has a base of about 300 feet. The area of the water surface may be stated at 605 acres, with a mean depth of twenty feet. The storage capacity is reported at 527,214,000 cubic feet at full stage.

There is a second dam to this reservoir across another channel which is used as the outlet for surplus water, and is provided with a spillway, built of cement masonry. A portion of this was torn down maliciously two years ago, and was repaired with brush and stone, and finished about three feet lower than before, thus reducing the storage capacity of the reservoir on a mean area of 580 acres by 75,794,400 cubic feet, or fourteen per cent of the total capacity. The spillway may be restored to its original hight for about $1,500.

The original reservoir which was (9) nine feet lower than the present one, was completed in 1859, at a cost of....	$69,100 45
During 1863, '4, '5, work was done to raise the water three (3) feet, at a cost of.....	7,580 06
From 1868 to 1872, inclusive, work was done to raise the water six (6) feet additional, at a cost of.....	131,611 94
The total cost of reservoir therefore has been.....	$208,292 45

without including land damage or repairs since 1872.

The Ischua reservoir was originally an old Mill pond which with its dam was appropriated by the State in 1858.

At that time the feeder was completed 2.91 miles long at a cost of	$37,827 81
And the feeder aqueduct at a cost of.....	5,082 66
Original cost; total.....	$42,910 47
In 1864, '5, there was expended in building a new dam, which was four (4) feet higher than the old one, and repairing feeder	7,251 10
In 1868, two spans of the aqueduct were rebuilt, cost	8,316 31
In 1869, the other four spans were rebuilt, cost.....	17,226 28

In 1869, '70, the dam was rebuilt with masonry abutments and the water raised an additional six (6) feet, cost....	$22,144 23
At the same time the feeder was enlarged, cost.....	3,807 78
Total cost up to 1870.....	$101,656 17

The Ischua dam is 230 feet long between stone abutments, and is built of timber and plank. The hight of the crest above the bed of the stream is fifteen feet. The water at the crest level covers about eighty acres, with a mean depth of seven feet, giving a storage capacity of 24,393,600 cubic feet.

The constant flow of Ischua creek renders this a much more important reservoir than its capacity indicates. The drainage area comprises about 67.700 acres.

The blue line around the reservoir follows the contour three (3) feet above the crest and contains 107 acres. The feeder is three and seventeen one-hundredths miles long. The feeder aqueduct has a wooden trunk fourteen feet wide by twelve feet high, supported in nine (9) spans of forty (40) feet each, by trapezoidal cast-iron trusses of the Whipple pattern, resting on masonry piers and abutments. The hight of the trunk floor above Oil creek, which it crosses, is thirty-two feet.

The Rockville reservoir was finished in 1843. It was let in connection with section 82, and no separate account of its cost is preserved. The final estimate was for $19,000, of which the reservoir probably cost $11,000. The engineer's estimate, before construction, was for $9,409.29. In 1854, a final estimate was made for construction of a new outlet, amounting to $5,767.07. In 1870, the outlet was improved and secured at a cost of $1,944.04, making its total cost, in round numbers, $19,000.

It has a dam twenty feet high, a water surface of seventy-two acres, and a capacity of 18,223,000 cubic feet. It is supplied from Black creek, having a drainage area of 15,563 acres.

The river dam, at Mount Morris, was rebuilt with a stone abutment at the east end, in 1873, at a cost of $12,886.05. The cribbing and crest of the dam were repaired, in 1876, at an expense of about $3,500, and, in 1877, at a further expense of $1,500, making a total cost of about $18,000, to which should be added the cost of the west abutment, estimated at $6,000, giving a total cost of $24,000.

The following dams have stone abutments:

Mill creek, at Dansville, sixty feet long.

Canaseraga creek, 132.5 feet long.

Allen's creek, Scottsville, 100 feet long.

Wiscoy creek, 100 feet long.

All the above-mentioned works afford fine water-power, which will be very valuable after the abandonment of the canal, the surplus water being generally used for hydraulic purposes at the present time.

There are nineteen aqueducts, most of which have cut stone abutments; thirty-one waste-weirs, generally with cut stone abutments; 119 culverts, several of them of cut stone; the most important being that over Big Black creek, in two arches of thirty feet span each.

There are twenty-nine locks of cut stone, of which eleven are north of Mount Morris, one on the Dansville branch, twelve north, and five south of the Summit. There are seventy-one composite locks, five of rubble masonry, and eleven wooden locks, making a total of 116 locks, of which four are guard-locks. The composite locks have cut stone wings.

There are 220 bridges, of which eighteen are iron, one wood, with iron chord, at Hinsdale, and 201 wood. Of the latter, ninety-three are road, ninety six are farm, seven are tow-path, four are road and change bridges, and one a foot bridge.

All the iron bridges and fifty-three of the wooden bridges rest on cut stone abutments, the remainder are generally supported on timber bents, on rubble stone foundations.

For a more detailed account of structures, see last year's report, page 185; also Canal Commissioners' report for 1876, page 167.

The navigation of the Genesee Valley canal has been interrupted by several breaks during the present season. The most important one occurred in the tow-path bank, a little north of Portage aqueduct, June fifteenth, carrying away 1,500 cubic yards of material. It was repaired by the superintendent with brush and stone, at a cost of about $1,400, and navigation was resumed after a detention of two weeks.

A scarcity of water was experienced on the Summit level during a portion of the month of September; otherwise the canal has furnished satisfactory navigation to those concerned. The amount of business done, however, has been very small.

The Chemung and Crooked Lake canals were transferred from the Middle to the Western Division by act of the Canal Board, January 3, 1877.

CHEMUNG CANAL.

The Chemung canal has been open to navigation during the season, with the exception of a few slight detentions. The business has been very light, however, averaging little more than one boat a day. On this account the locks which are in an advanced state of decay have been made to last without any extensive repairs. The canal is navigable from Watkins to Horseheads, seventeen miles, and the feeder from thence to the dam, fourteen miles, and the Chemung river by slack-

water thence to Knoxville, two miles; total, thirty-three miles. The canal from Horseheads to Elmira, six miles, has been closed for some years. The canal was first opened to navigation in 1834.

The river front at Corning being on slack-water, caused by the State dam, has been protected by a line of docking, built and maintained by the State. This docking is half a mile long and about nineteen feet high. An appropriation of $3,000 was made by the last Legislature to repair portions of the docking which is fast going to decay. The work will be done by the superintendent, and will cost more than the sum named.

There is on the canal one composite lock, with cut stone wings, all the rest are of wood, and nearly worthless. It is doubtful whether it will be possible to maintain navigation another year.

There are four (4) iron bridges, on stone abutments. The remainder are of wood, a few built recently, but all of comparatively small value.

CROOKED LAKE CANAL.

This canal, eight miles long, including one mile of lake navigation at Penn Yan, was opened to boats in 1834. It is now permanently closed, and, in some places, filled up, where bridges have failed. There are twenty-eight locks, including the guard-lock at Penn Yan, of which twelve are built of stone, and sixteen are composite.

ENGINEER DEPARTMENT.

This department has been in charge of Wm. H. Searles, division engineer, during the year. The office of resident engineer was made vacant on the twenty-first of May, by the death of Byron M. Hanks, after a service of twenty-five years upon the canals.

Thomas Evershed was appointed resident engineer, and has held the office since June 12, 1877.

Table No. 1 contains the names of the assistants employed on the division for the year, both on ordinary and extraordinary repairs, with the time of service and rate of compensation of each; also, the incidental expenses of this office.

Table No. 2 is an exhibit of the character and condition of the work under contract as extraordinary repairs during the year.

Respectfully submitted.

WM. H. SEARLES,
Division Engineer, W. D.

TABLE No. 1.

Statement showing names, rank, number of days and compensation of Engineers upon the Repairs of the New York State Canals, together with incidental expenses during the fiscal year ending September 30, 1877, under act chapter 169, Laws of 1863.

ERIE CANAL, REPAIRS, FROM OCTOBER 1ST, 1876, TO SEPTEMBER 30TH, 1877.

NAMES.	Rank.	Number of days.	Rate of compensation.	Amount.	Total.
W. H. Searles	Division Engineer	Salary	$2,400 p'r an.	$1,600 00	
W. H. Searles	Division Engineer	Travel	6c per mile	379 14	
Byron M. Hanks	Resident Engineer	Salary	$2,000 p'r an.	810 25	
Byron M. Hanks	Resident Engineer	Travel	6c per mile	376 98	
Thomas Evershed	Resident Engineer	Salary	$2,000 p'r an.	480 64	
Thomas Evershed	Resident Engineer	Travel	6c per mile	137 22	
W. N. Radenhurst	Assistant Engineer	180 days	$5 per day	900 00	
John Bisgood	Assistant Engineer	118 days	$5 per day	590 00	
Daniel Boutecou	Leveler	79 days	$4.50 p'r day	355 50	
					$5,629 73
Incidental Expenses.					
Stationery				$86 93	
Fuel, light and office rent				428 25	
Postage and telegraph				78 55	
Miscellaneous				40 13	
					636 86
Total					$6,263 59

TABLE No. 1 — (Continued).

GENESEE VALLEY CANAL REPAIRS FROM OCTOBER 1, 1876, TO SEPTEMBER 30, 1877.

NAMES.	Rank.	Number of days, etc.	Rate of compensation.	Amount.	Total.
W. H. Searles	Division engineer	Salary	$2,400 p'r an.	$700 00	
W. H. Searles	Division engineer	Travel	6c. per mile.	37 74	
B. M. Hanks	Resident engineer	Salary	$2,000 p'r an.	426 50	
B. M. Hanks	Resident engineer	Travel	6c. per mile.	83 64	
Thomas Evershed	Resident engineer	Salary	$2,000 p'r an.	63 00	
Thomas Evershed	Resident engineer	Travel	6c. per mile.	14 88	
W. N. Radenhurst	Assistant engineer	80 days	$5 per day.	400 00	
					$1,775 76
Incidentals.					
Stationery				$14 70	
Fuel, light and office rent				167 40	
Postage and telegraph				21 34	
Miscellaneous				5 50	
					208 94
Total					$1,984 70

TABLE No. 1 — (Continued).

CHEMUNG AND CROOKED LAKE CANALS REPAIRS FROM 1ST JANUARY TO SEPTEMBER 30, 1877.

NAMES.	Rank.	Number of days, etc.	Rate of compensation.	Amount.	Total.
W. H. Searles	Division engineer	Salary	$2,400 p'r an.	$50 00	
W. H. Searles	Division engineer	Travel	6c. per mile.	13 32	
B. M. Hanks	Resident engineer	Salary	$2,000 p'r an.	46 58	
B. M. Hanks	Resident engineer	Travel	6c. per mile.	15 18	
Thomas Evershed	Resident engineer	Salary	$2,000 p'r an.	62 00	
Thomas Evershed	Resident engineer	Travel	6c. per mile.	11 28	
					$198 36

Recapitulation. — Repairs proper from October 1, 1876, *to September* 30, 1877.

Erie canal	$6,263 59
Genesee Valley	1,984 70
Chemung and Crooked lake	198 36
Total	$8,446 65

TABLE No. 1 — (Continued).

Statement showing names, rank, number of days and compensation of Engineers upon the extraordinary repairs of the Western Division of the New York State canals, and paid by the Division Engineer of the Western Division between the 1st of October, 1876, and the 28th February, 1877.

ERIE CANAL — EXTRAORDINARY REPAIRS, ERIE SURVEY, CHAPTER 425, LAWS OF 1876.

NAMES.	Rank.	Number of days.	Rate of compensation.	Amount.	Total.	Grand total.
John Bisgood	Asst. Engin'r in charge,	90	$6 00	$540 00		
Daniel Bontecou	Leveler	130	4 50	585 00		
Robert P. Staats	Leveler	93	4 50	418 00		
W. B. Maxwell	Rodman	106	3 50	371 00		
A. A. Simpson	Rodman	106	3 50	371 00		
Jerome Hathaway	Chainman	19	2 50	47 50		
I. H. Eldridge	Chainman	19	2 50	47 50		
William Bradley	Chainman	19	2 50	47 50		
					$2,428 00	
Incidentals.						
Towing scow up to October 19				$81 85		
Cash paid for current float				1 37		
Rubber stamp				5 00		
					88 22	$2,516 22

ERIE CANAL, EXTRAORDINARY REPAIRS, REPAIRING BIRD ISLAND BREAKWATER, BUFFALO HARBOR.
Appropriation, Section 3, chapter 425, Laws of 1876.

W. N. Radenhurst	Asst. Engin'r in charge,	55	$6 00	$330 00	$330 00	
						330 00
						$2,846 22

SUMMARY OF TABLE NO. 1.

Engineering expenses for fiscal year ending September 30, 1877.

NAME OF CANAL.	Engineering proper.	Incidentals.	Amount.	Total.	Grand total.
Repairs, ordinary, Erie	$5,629 73	$633 86	$6,263 59		
Repairs, ordinary, Genesee Valley	1,775 76	208 94	1,984 70		
Repairs, ordinary, Chemung and Crooked Lake	198 36	.....	198 36		
				$8,446 65	
Repairs, Extraordinary, Erie.					
Erie survey	$2,428 00	$88 22	$2,516 22		
Bird Island Breakwater	330 00	.....	330 00		
				2,846 22	
					$11,292 87

TABLE No. 2.

Statement of work done under contract, and under the supervision of the Engineering force, upon the Western Divison of the New York State canals, for the fiscal year ending September 30, 1877.

ERIE CANAL.

CHARACTER OF WORK.	Amount of appropriation.	When let.	When to be completed.	Engineer's estimate, with engineering and contingencies added.	Amount paid during fiscal year.	Total amount paid since commencement of work.	Remarks.
1 Constructing a road bridge over canal on the highway running from the Palmyra road to Cartersville road, in the town of Pittsford.....	$4,000 00	Oct. 22, '74	Apl. 20, '75	$4,000 00	$853 31	$2,553 31	Completed.
2. Repairing Bird Island breakwater.....	15,000 00	.....	.....	14,900 55	12,132 22	12,031 78	Completed.

WESTERN DIVISION.

REPORT ON ERIE SURVEY, 1876.

ENGINEER DEPARTMENT, WESTERN DIVISION,
ROCHESTER, N. Y., *March* 1, 1877.

Hon. JOHN D. VAN BUREN, JR., *State Engineer and Surveyor:*

SIR.— Pursuant to act chapter 425, section 6, Laws of 1876, providing for a survey of the Erie canal, a corps of engineers was organized on this division in the month of June last, under Mr. John Bisgood, assistant in charge. The State scow "Scovill" was obtained from Commissioner Jackson for the use of the corps, and was housed in and plainly furnished, so as to make comfortable quarters for the men. An arrangement was made with Mr. Hathaway to furnish them with meals on board, his wife taking charge of the culinary department. Every thing being in readiness, the scow was towed from Rochester to Clyde, and field operations were commenced at Clyde lock (No. 53), on the morning of June 21st, 1876.

FIELD WORK.

The object of the survey was to ascertain the actual condition of the tow-path, berme, prism and structures, and the depth of water throughout, for the purpose of deciding upon where and in what particulars the canal requires repairs. To this end the distance from lock to lock wa measured with a 66 feet chain, along the front angle of the tow-path, making the east hollow quoin of each lock the starting point for the level west of it.

Cross-sections were taken at regular intervals (usually once in two chains), at right angles to the tow-path, by a sounding rod under water and by the leveling rod on tow-path and berme. A line of levels was run at the same time, by which the elevation of the water surface was ascertained at each cross-section, and permanent benches were established on every important piece of masonry. The exact position of a bench on the coping was indicated by four cuts of a cold chisel, forming a figure about two inches square, thus,  a description of its position being recorded in the field books. Benches were placed near the hollow quoin of each lock, on the wing of each bridge abutment, and on the coping of culverts, waste weirs, etc.

In this manner the survey proceeded regularly from Clyde lock to the guard lock at Black Rock, which was reached on the seventeenth of October, having occupied nearly 17 weeks, but fully 14 days of this time were lost by the prevalence of high winds, which made it impossible to use the level with any assurance of accuracy.

The total distance chained is 11,457.48 chains, or 143.218 miles; the number of cross-sections taken is 5,509; the aggregate length of cross-sections measured is 661,616 feet, and the total number of soundings is 71,882; the number of benches established is 243. The corps then returned to Rochester, stopping at various places to take a few supplementary measurements, and more particularly to note the velocity of the current at certain points. For this purpose a wooden float of seasoned white pine, 2 inches diameter, was provided, having a tin tube attached to the lower end, and filled with shot to sink it to the proper depth and keep it in a vertical position. It was immersed six feet and projected a few inches above the surface of the water. It was placed in the channel, and the time of its passage over measured distances noted. The distances varied in different experiments from 5 to 40 chains.

The corps reached Rochester on October twenty-first, and was disbanded, and the scow was returned to the custody of the superintendent of the Genesee Valley canal. Several members of the corps were retained for office work.

TEST LEVELS.

During the progress of the survey, a leveling party of two was sent out to test the benches established, and after the close of the survey proper, a second party of two was detailed for the same duty. These parties, owing to the lateness of the season, were very much troubled with the high winds which prevailed, especially on the western end of the division. Scarcely a day was entirely free from wind moving at the rate of from twelve to twenty miles an hour. After many vexatious delays from this cause, the test levels were finally completed, and the gentlemen so engaged returned to work in this office. The result of their labors are entirely satisfactory, showing a high degree of accuracy with levels.

PROBABLE ELEVATIONS.

Neither the first nor last running has been adopted as correct, but the probable elevation has been deduced from all the notes taken. In fifty-seven instances, the difference of level between two consecutive benches has been taken three times (including the survey levels), and in two instances we have the results of four runnings, and in still two others of five runnings between consecutive benches, from which was deduced the most probable difference of level, giving proper weight to each observed difference. The result shows that the greatest probable error,

in the difference of level of any two consecutive benches on the division, is .015, which occurs but once. The probable error of .014 occurs five times; .013 occurs four times; .012 occurs twice; .011 occurs twice, and .010 occurs four times. The average probable error, in the difference of elevation of consecutive benches, is a little less than .004.

Having determined the probable value of all the differences of elevation of consecutive benches, the elevation of the bench at Clyde was assumed from the old profiles at 397.509 above tide, and from this the elevation of all the other benches was easily computed. By this process, the probable elevation of the bench on the Rochester aqueduct was found to be 508.287, with a probable error of + .026, and differing .125 from the result of the first levels taken on the survey. The probable elevation of the bench on lock 67 (Lockport) was found to be 522.352, with a probable error of + .002, though differing from the elevation given on the first running by .389, which is the greatest variation that occurs between the probable elevation of any bench, and its elevation as given by the first levels taken on the survey. Finally, at Black Rock, the bench on the guard-lock, at the upper hollow quoin on the south (east) side was found to have a probable elevation of 574.152, with a probable error of + .044, and differing from the elevation given by first line of levels by .181.

Subsequently a correction of + 1.440 was received from the eastern division, and + .422 from the middle division, making a total of + 1.862, which applied to the elevation of the Clyde lock bench, as found by survey of the middle division (397.172), gives the corrected elevation of 399.034 for that bench.

As this is 1.525 higher than the assumed elevation of 397.509, which was used as the basis of survey on the western division, it became necessary to add 1.525 to all our elevations.

This makes the probable elevation of the Rochester aqueduct bench 509.812; of the lock 67 bench, 523.877, and of the Black Rock guard-lock bench, 575.677 above mean low tide at Albany. The table of benches, presented herewith, contains the elevations as originally taken, and also the probable elevations resulting from corrections for test levels and change of datum. All other elevations, given in this report, are the finally corrected elevations.

The surface of Lake Erie, as it stood October 17, 1876, is found to be (564.85, first survey, 1816) 572.926 above mean low tide at Albany.

The surface of the lake is subject to considerable fluctuations, amounting, frequently, to one or two feet, and sometimes to as much as five or six feet at Buffalo.

At the date named it was about 1.25 above what is considered the ordinary stage, which would make the latter 571.68 above datum.

ESTABLISHMENT OF GRADES.

On each level, east of Rochester, the grade of the bottom is assumed to be level and to coincide with the higher one of the two lower mitre-sills in the lock at the west end of the level. The difference in the elevation of lower mitre-sills, in the same lock, varies from .020 to .310, as may be seen in the table of locks, so that it became necessary to select the higher one in determing grade.

All grades of the bottom, west of Rochester, have a descent eastward, as shown on the accompanying profile, and in the table of grades and surface descent. These grades have been selected after a careful consideration of all the conditions involved, and while they agree with the average bottom of the canal, and with the sills of stop-gates and other structures, are sufficiently below the water surface at every point, not merely to float boats, but to afford the necessary area of water-way to pass or discharge the volume of water requisite to maintain navigation at all points below.

PROFILES.

The profiles are drawn to a horizontal scale of 40 chains to an inch, and a vertical scale of 3 feet to an inch, thus magnifying the hights, relatively, 880 times, and clearly showing variations of one-tenth of a foot.

The *red line indicates* the grade of the bottom; the *yellow line the* grade of the tow-path, and the *blue full line* the grade of the water surface.

The *lower shaded line indicates* the bottom of the canal on a line 40 feet distant from the front angle of the tow-path; the *unshaded line indicates* the bottom of the canal on a line *generally* 15 feet from the front angle; but in cases of vertical wall, on tow-path side, only 8 feet from front angle, and in case of slopes flatter than 1¼ to 1, at a point over the intersection of slope and grade.

The *upper shaded line is* the profile of the center of the tow-path, and the *dotted blue line is* the surface of water, as found in survey, except between Rochester and Holley, where the surface found, during the taking of test levels, is substituted therefor.

The lifts of the locks are not graphically represented, except at Black Rock.

It is evident, at a glance, that the center of the canal is generally below grade, and in no place projects much above it, while near the angle of the prism there is almost uniformly an accumulation of mud of variable thickness, much of which may, with advantage to navigation, be removed.

No profile of the bottom over the berme angle has been made. It

would only differ from the unshaded line in showing, as a rule, a somewhat greater accumulation of sediment. The berme bank is shown in profile on embankment only. The ridge line, or line of highest ground, is represented by the black line, while the yellow line shows the hight required by law and for safety.

The profile of the berme is given on a separate sheet from the others to avoid confusion. The profiles represent every section measured on the survey, and are, therefore, a complete and accurate exhibit of the present condition of the canal, so far as the lines represented are concerned.

It is proper to remark that the dotted blue line is not a profile of the actual water surface at any one time, but of the water as it was found from day to day, and from point to point, whether high or low, as the survey proceeded.

CROSS-SECTIONS.

The cross-sections of the canal taken on the survey have been referred in plotting to the grades shown on the accompanying profile. The horizontal scale for the cross-sections is taken at twenty feet per inch, while the vertical scale is taken at five feet per inch, thus magnifying the hights relatively four times, and rendering distinct to the eye the amounts by which the actual bottom differs from grade.

The width of the canal is found to be extremely variable, even sometimes in adjacent sections, and, as a whole, it cannot be said to conform to established regulations either in top width, bottom width or slopes. Since, however, the sides are generally lined with vertical or slope wall, it has been considered better to assume the widths of the sections, as now found, rather than to represent the regulation widths and slopes, since the red lines so drawn would indicate a large and very unnecessary amount of work to be done. The slope lines then have been drawn so as to show the amount of material necessary to be removed in order to put the canal in the best condition possible under the circumstances.

The blue line across the sections shows the proper surface of water, not the surface found at the date of survey.

The sections show also the present condition of the tow-path and berme banks, which, in many places, are much too low and require immediate repairs. The yellow line shows the section of proposed repairs.

Where the tow-path is on the *north side* of the canal, it appears on the *left* side of the page, and *vice versa.*

The horizontal measurements of the cross-section extend in either direction from the line of survey along the front angle of the tow-path, which is placed in the line marked 0 or 80 as the case may require.

The cross-sections have been taken in some parts of the canal at every

chain; in others, where the canal was in better condition, only once in three or four chains, but generally at every two (2) chains.

Between Tonawanda and Black Rock they were taken only once in ten chains. All cross-sections surveyed have been plotted in the books provided for the purpose.

The notes received from the Middle Division for the canal between Wayne county line and Clyde, are made for every chain, but as the odd stations are found generally to be copies of the even stations, they were not plotted when such was the case.

The material of the bottom is not indicated in these sections, because it was found impossible to determine its character with any satisfaction or certainty, in the limited time allowed for the survey, incorrect information being considered worse than none. The original sections and final estimates in the possession of this department show the kind of material in every case, and may be used for that purpose.

GRADES BETWEEN BLACK ROCK AND LOCKPORT.

By reference to the profile and table of grades and surface descent, it will be seen that, beginning at Black Rock, on the lower miter-sill of the guard-lock, the grade line has a descent of .08 per mile to Tonawanda; thence a descent of .0144 per mile through Tonawanda creek and the canal, east of Pendleton, to Sulphur Spring guard-lock; thence a descent of .268 per mile to Murphy's culvert, near the head of the rock cut; thence a descent of .096 per mile to lock 71 at Lockport. There is a depth of nine feet on the grade from Black Rock to the Sulphur Spring guard-lock, subject, however, to the fluctuations of Tonawanda creek, and of 9.50 from Murphy's culvert to lock 71, the increased depth being intended to compensate in part for the narrowness of the canal through the rock cut.

So far as I am aware, no grade and water surface has ever been established by the Canal Board for this portion of the canal. The only resolutions existing are those of September 22d, 1849, and September 7th, 1850, which provide for a "top water-line," 100 feet in width, between Tonawanda creek and Sulphur Spring guard-lock, and 90 feet in width from thence to the rock cut, and a depth of eight feet in each case, and slopes of 1½ to 1.

The following abstract exhibits all that is said on the subject in the annual reports of past years.

Abstract from engineer's annual reports upon the dimensions and grades of the Erie canal, between Black Rock and Lockport.

NAME AND DATE OF ANNUAL REPORT.	Items.	Between Black Rock and Tonawanda.		Between Tonawanda and Pendleton.		Between Pendleton and Sulphur Spring.		Between Sulphur Spring and Rock Cut.		Between head of Rock Cut and Lockport.	
		Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.
John D. Fay, division engineer, annual report 1858, p. 63	Surface width	80	..	..	..	100	..	90	..	62	..
	Bottom width	60	..	..	..	..	..	..	..	62	..
	Depth	9	..	..	..	9	..	9	..	9	..
Wm. B. Taylor, State Engineer and Surveyor, annual report 1862, p. 439	Surface width	80	..	200	..	100	..	100	..	62	..
	Bottom width	60	..	..	..	77½	.	77½	..	60	..
	Depth	9	..	9	..	9	..	9	..	9	..
	Elevation surface	568½	..	..	..	..	..	..	.	568	42
John D. Fay, division engineer, annual report 1874, pp. 77 and 78	Surface width	92	..	200	..	100	..	100	..	62	..
	Bottom width	72	..	..	..	96	..	96	..	62	..
	Depth	8	..	9-|-	..	8	..	8	..	9	..
	Descent of grade	..	8	..	4	..	2	..	2½	.	2½

From the above, it appears that no attention was paid to the descent of the surface up to the year 1862, and the descent mentioned in the report of 1874 is somewhat arbitrarily assumed for lack of sufficient data.

It also appears that the depth has always been nine feet or more between Black Rock and Lockport, subject to the fluctuations of the surface.

GRADE BETWEEN LOCKPORT AND ROCHESTER.

The following tabular statement presents, at one view, the several regulations concerning the grade and surface of the canal between Lockport and Rochester:

DATE OF RESOLUTION.	Items.	At Lockport. Lock 67.	ROCHESTER AQUEDUCT.		Lock 66.
			West End.	East End.	
September 16, 1850	Water surface	M. sill—7 ft. 6 in.	Aq. bot.—7 ft. 4 in.	Aq. bot.—7 ft. 4 in.	Aq. bot.—7 ft.
	Grade	M. sill—1 ft. 6 in.	Aq. bot.—1 ft. 8 in.	Aq. bot.—0 ft. 8 in.	Aq. bot.—1 ft.
	Depth of water	9 ft.	9 ft.	8 ft.	8 ft.
	Descent of surface	3 ft. 8 in.		0 ft. 4 in.	
	Descent of grade	3 ft. 8 in.		0 ft. 4 in.	
	Mean width	91 ft.	62 ft.	60 ft.	60 ft.
July 7, 1854	Water surface	M. sill—7 ft. 6 in.	Aq. bot.—7 ft. 4 in.	Aq. bot.—7 ft. 4 in.	Aq. bot.—7 ft.
	Grade	M. sill—1 ft. 6 in.	Aq. bot.—0 ft. 2 in.	Aq. bot.—0 ft. 8 in.	Aq. bot.—1 ft.
	Depth of water	9 ft.	7 ft. 6 in.	8 ft.	8 ft.
	Descent of surface	3 ft. 8 in.		0 ft. 4 in.	
	Descent of grade	2 ft. 2 in.		0 ft. 4 in.	
	Mean width	91 ft.	62 ft.	60 ft.	60 ft.
September, 1854	Water surface	M. sill—7 ft. 9 in.	Aq. bot.—7 ft. 1 in.	Aq. bot.—7 ft. 1 in.	Aq. bot.—7 ft.
	Grade	M. sill—1 ft. 3 in.	Aq. bot.—0 ft. 2 in.	Aq. bot.—0 ft. 8 in.	Aq. bot.—1 ft.
	Depth of water	9 ft.	7 ft. 3 in.	7 ft. 9 in.	8 ft.
	Descent of surface	4 ft. 2 in.		0 ft. 1 in.	
	Descent of grade	2 ft. 5 in.		0 ft. 4 in.	
	Mean width	91 ft.	62 ft.	60 ft.	60 ft.

Act chapter 399, section 3, Laws of 1874, appropriated $20,000 for deepening the canal an average of six inches below established grade, from "wide water" west of tow-path change bridge to east end of aqueduct. This work was done under resolution of Canal Board, July 28, 1874, but "established grade" was not changed. The bottom of the aqueduct was lowered six inches also in the winter of 1874–75.

The regulations of September, 1854, as shown in the above table, are the last on this subject, and are, therefore, in force at the present time. Reduced to elevations above tide-water, they become as follows:

Table showing the elevations by Erie survey of 1876, *of the grade and water surface established by resolution of Canal Board, September*, 1854.

ITEMS.	Lockport. Lock 67.	Rochester Aqueduct.		Lock 66.
		West end.	East end.	
Water surface elevation	511.890	507.750	507.750	507.667
Grade elevation	502.890	500.500	500.000	499.667
Depth of water	9.000	7.250	7.750	8.000
Descent of surface	4.140	.....	0.083	.....
Descent of grade	2.390	.....	0.333	.....

The profile of the bottom shows that the canal has never been excavated fully to the old grade line thus established, especially on the western end of the grade. The "established grade" is above the present bottom of the Rochester aqueduct, and above the mitre-sills of the stop-gates at Adam's Basin and east of Holly. It is a broken grade, stepping down vertically at each end of the aqueduct and being unnecessarily steep east thereof.

I have considered it important to have a *uniform grade*, from lock 67 to 66, low enough to conform as nearly as may be to the bottom of the Rochester aqueduct and to the mitre-sills of stop-gates, and at the same time high enough to avoid unnecessary excavation in any future effort that may be made to reduce the botom of the canal to grade. The new grade line, shown on the profile, fulfills these conditions.

It begins at a point one foot below the top of lower mitre-sill of lock 67 and descends at a uniform rate of .048 per mile to lock 66, passing .062 above the bottom of the Rochester aqueduct and terminating .160 below the breast wall of the new lock, but .010 above that of the old lock, No. 66. It passes .139 above the mitre-sill of stop-gate east of Holly, and .229 below the bottom of stop-gate west of that place, and .055 below the bottom of stop-gate east of Medina. The old grade is .250 lower than the new, at Lockport, crosses it at station 2712, near

Albion, is .282 above it at west end of Rochester aqueduct, .214 below it at the east end of aqueduct, and .437 below it at lock 66. The old grade is not shown on the profile, as it would only serve to confuse.

The proposed regulation depth of water, at lock 67, is 8 feet on grade, or 7 feet on the mitre-sill, but the surface line is not parallel to the grade, neither is its descent uniform, so that the depth of water on grade varies as we pass from Lockport to Rochester. From 8 feet, at Lockport, it decreases to 7.575 at station 2500, near Hindsburgh, thence remains uniform to station 1500, at Cooley's Basin, and thence increases again to 7.710, at lock 66.

While all the grades east of Rochester are level, a slight fall of the surface is allowed for, on the twelve-mile level between locks 59 and 60, by raising the water to 7.165 on the lower mitre-sill of the latter; on the seventeen-mile level between locks 61 and 62 by raising the water to 7.343 on the lower mitre-sill of the latter, and on the short level between locks 62 and 63 by raising the water to 7.063 on the lower mitre-sill of the latter.

CALCULATION OF SURFACE DESCENT.

The rate of surface descent, as given in this report, has been carefully calculated from point to point, due regard being paid to the actual size and shape of the canal prism through all its sections.

The data used for this purpose are as follows: *the required depth of water* upon the grade line, the *average area of the actual water-way* due to that depth (determined by a calculation of the area of the actual cross-sections measured on the survey), the *mean value of the actual wet perimeters*, and lastly, the *required average discharge of water per minute.*

The formula which I have employed is $f=\frac{p(V+6.534)^2}{6119.6A.}$ and $V=\frac{D}{A.}$

in which f=the fall of surface in feet per mile.

A=area of water section in square feet.

p=wet perimeter in feet.

V=mean velocity in feet per minute, and

D=discharge in cubic feet per minute.

This formula I have deduced from the well-known formula of Eytelwein.

$$F = .000111415 \frac{p}{A} v^2 + 0000242647 \frac{p}{A} v.$$

in which F = fall of surface in feet per foot.

and v = mean velocity in feet per second.

To obtain the value of the wet perimeter, I selected a number of sections whose mean area was equal to the mean area of all the sections taken

on the portion of canal under consideration, and having plotted these on a large scale, measured their wet perimeter. The area of each of these selected sections was then divided by its wet perimeter giving a certain ratio. The mean of these ratios was found, and the mean area of all the sections divided by the mean ratio gave the mean wet perimeter required.

The mean discharge is assumed so as to comply with the requirements of navigation after supplying all losses due to evaporation, filtration and properly constructed weirs, *but not open gates.*

The rate of descent being thus determined for a given average discharge of water, the discharge at the upper was assumed to be enough greater than the average, and at the lower end enough less to provide for the estimated losses by the way on the length of canal under consideration. While not strictly correct, this method is as close as the given data in the case, and answers every practical purpose. The theoretical water surface so determined, becomes the standard level for the water, and the profile shows that the water in its fluctuations averages very nearly this standard, thus confirming roughly the correctness of these calculations.

The first length of canal considered is from Black Rock to Tonawanda, 7.86 miles, and since this is supplied from Lake Erie, there is no difficulty in keeping the surface at the standard level, and so providing the discharge required.

The second length of canal considered is from Tonawanda to Pendleton (11.73 miles), in the bed of Tonawanda creek, and from Pendleton to Sulphur Spring guard-lock (1.52 miles), making together 13.25 miles.

The surface descent through Tonawanda creek is nominal, and is not subject to control, except indirectly, by feeding at Black Rock. The water flows sometimes in one direction, and sometimes in the other, according to the stage of the creek at Pendleton. But during the season of navigation there is a pretty general flow eastward, about as shown in the table. The increase of discharge shown at Tonawanda is an allowance made for the water coming from the creek and its tributaries.

The third length of canal considered is from Sulphur Spring to Murphy's culvert, 2.45 miles, and the fourth, from the latter point to Lockport, 2.73 miles. Owing to the change in form and size of section near the culvert, the surface takes a different descent as it passes that locality, but the supply of water is regulated at Sulphur Spring only.

The velocity given the water by the descent fixed upon is somewhat in excess of half a mile per hour, both at Black Rock and Lockport. At Black Rock the velocity will not be materially changed from that heretofore existing, when properly regulated, but between Sulphur Spring

and the Rock cut, from 1.05 to .68 miles per hour, a reduction of 65 per cent. At the same time, the discharge of water will be more than ample for all purposes of navigation, allowing for a waste of 2.950 cubic feet per minute at Lockport, and still having 33,755 cubic feet per minute to supply the canal east of that place, which is slightly in excess of any amount that has heretofore been considered by canal engineers to be necessary to navigation at that point.

Indeed the descent and consequent velocity and discharge might be still further reduced but for the fact that the water on the long grade below Lockport is subject to fluctuation by the force of the wind, so that it is prudent to have some surplus at command to use in case of necessity. If not needed the surplus will discharge itself by waste-weirs.

The long grade between Lockport and Rochester has been divided into ten lengths of 6.25 miles each, for the purpose of determining the proper surface descent. Each length has been treated in the manner above described, by finding the actual average area and perimeter of water-way. The discharge on each length after the first evidently depends upon what quantity of water can be received from the preceding length, and therefore could not be assumed at random. Due allowance was made for losses by filtration and evaporation, which were assumed to be at the rate of 190 cubic feet per mile per minute, and also for losses at the several waste-weirs after they shall have been properly repaired and graded.

The surface line thus found has a descent in the first, 6.25 miles from lock 67, of .068 feet per mile, but the descent gradually becomes less and less on the succeeding lengths, until, on the last one, at Rochester, it is only .028 feet per mile. These details are shown in full in the table of grades and surface descent, and by the full blue lines of the profiles. This blue line being obtained by purely theoretical considerations, grounded on the facts in the case, its general adherence to the actual water surface, shown by the dotted line, proves not only the correctness of these calculations, but the excellence of the formulas employed.

The fact that the dotted line is below the full line from Middleport to Rochester is accounted for by the excessive loss of water which was permitted at various points from Lockport east. Were these losses prevented, there is no doubt but that the surface would coincide very closely with the blue line indicated, giving an increased depth of water with a decreased velocity.

It should be noted here that in estimating the total fall of surface on the last 6.25 miles, the surface is assumed to be level along the wide water, a distance of twenty-nine chains, so that the total fall is $.165 = .00035 \times (500-29)$.

The seventeen-mile and twelve-mile levels were each considered in two equal portions, but the surface descent was found to be so nearly identical in the two halves, that an average grade uniform throughout each level has been assumed instead. The level (lock 63–62) just west of the seventeen-mile level has also been assigned a surface descent, in order that it may more surely afford the necessary supply of water.

The levels east of lock 59 have so slight a descent that it has not been considered.

The field work done by the middle division gives the mitre-sill of Clyde lock (53) .50 higher than the mitre-sill of Port Byron lock (52). We are therefore compelled to keep the water a half a foot higher on this division, and in order to do so properly, the water should be kept at 7.50 on the mitre-sill at Port Byron. For this purpose it will be necessary to raise the flush-board on the Seneca River aqueduct three-tenths (.30), and the bridge at Wayne county line nine-tenths (.90), it having always been too low.

By the table of grades the amount of water passing lock 59 is shown to be 6,154 cubic feet per minute. The losses of all kinds between that lock and the aqueduct are estimated to be 5,040, leaving 1,114 cubic feet per minute to pass over the spillway of the aqueduct. Allowing as much more to come from the east, gives a total of 2,228 cubic feet per minute.

The spillway is 682 feet long, hence its depth below surface should be .086. Allowing for a fall of .01 per mile in eleven miles from Clyde, the surface at the aqueduct will be 392.074, less .110=391.964; and 391.964 less .086=391.878=proper elevation of spillway. Present elevation (average)=391.578; difference=.300.

WASTE-WEIRS.

The accompanying table of waste-weirs gives at one view nearly all the information required concerning these structures. There are twenty-nine structures from which water may be discharged, including the State race at Lockport, three aqueducts and one weigh-lock. The total length of spillways is 1202.11 feet. The copings are set almost at random, and certainly without regard to any systematic profile whatever. Some are so high that the water never reaches them, others are so low that the loss of water is extravagant. The total amount of water passing over the weirs in their present condition, when the canal is at proper stage, is about 17,000 cubic feet per minute, so far as ascertained, the taking of elevations having been omitted where the interrogation marks appear in the table. The figures in brackets [ ] are not included in this estimate, as they show what the discharge would be without flush-boards.

Were the weirs regulated as they should be, the loss would be about 10.986, although some weirs would be active, which are not so at present. It is important that the weirs should be adjusted to their proper level, as they cannot regulate the surface when otherwise.

There are 100 gates by which water may be discharged, having an aggregate area of 665.67 square feet and capable of discharging from a full canal 469,683 cubic feet per minute.

The waste-weirs at Brighton and Newark discharge into the levels below them, so that the water is not lost to navigation.

MILL RACES AND DRY DOCKS.

At Lockport there is a race leading from the canal, above the locks, to the works of the Holly Manufacturing Company, but this water is returned to the canal below the locks. On the south side of the canal, at the same place, is a race used by the Hydraulic Company, which does not return all the water of the canal as required by law, a portion of it passing under the canal, by the culvert, west of Exchange street. The gates opening into the Holley race are 8 in number, 3 feet × 4 feet 4", having a combined area of 104 square feet. The gates opening to the south side race are 8 in number, 4', 6" × 4', and there is one other of the same size opening at once to a mill. The aggregate area of the 9 gates is 162 square feet, which, added to the former, gives a total of 266 square feet of outlet from the canal at this point, exclusive of the locks, or about half the average area of the canal in the rock cut. The dam across the creek, at Tonawanda, has not been included in the table of waste-weirs. Its crest is uneven, but is generally above the surface required for navigation. It has 12 waste gates, 4 feet by 5 feet, the total area being 240 square feet. These are intended to regulate the creek in time of flood. The water discharged from them passes almost directly into the Niagara river.

There are two dry docks at Lockport, each having two outlet gates, 2½ × 3 feet, a total area of 30 square feet, with 12 feet head. They lead into the State race, a closed flume, which feeds a turbine in Cady's mill, with a head of about 20 feet from canal surface.

In addition to these there is a "logway" passing along the side of the dry dock to the same mill, having one gate, 2½ × 3 feet wide, in its side, and terminating a flume 6 feet wide, with gates inaccessible to measurement.

All these feed turbines in Cady's mill, and the water used, is lost to the canal. This mill has no other source of power than the canal. The gates mentioned are controlled by the mill owner. There is a dry dock at Middleport, all the water passing through which is lost to the canal, and serves to drive mills on the creek below.

The dry-docks at Rochester and Newark discharge there water into lower levels of the canal.

REGULATION OF THE FLOW OF WATER.

Up to the present time no permanent marks have ever been established to indicate the proper hight of the water surface, and as a consequence the regulation of the water has been a matter of guess-work, depending on the caprice of the person having it in charge at any point. Great fluctuations have been permitted, as though a flood sent down at one time would atone for a scarcity of water at another.

It is proposed to establish on every lock-wall a definite horizontal line, cut with a cold-chisel and painted above and below in two colors, which shall indicate the precise regulation hight of water surface at that point.

Similar marks may be placed at other points on a long level. A scale of inches, numbered up and down from the surface mark, will indicate to boat captains and others the amount of deviation, if any, of the surface, from its proper stage. It will be the duty of the party in charge simply to keep the surface steadily at the water-mark, or to restore it to that stage should it be discovered to have fluctuated.

A uniformity of water surface at the upper end of a level will of course insure uniform and sufficient depth of water and velocity of current throughout, unless affected by extraneous disturbances at other points.

Since the western division of the canal is almost wholly dependent on Lake Erie and Tonawanda creek for a supply of water, it is necessary that the water should flow steadily through the prism at such a velocity, that at all points, even to the eastern extremity of the division, the canal may be at all times fully supplied. On the other hand, it is equally essential to the interests of navigation that the velocity of current should be no greater than absolutely necessary to secure this end. The maximum velocity of current should not exceed one-half mile per hour. This is a limit established by long experience, and in which both engineers and boatmen are agreed.

The table of grades, etc., shows that the velocity between Black Rock and Lockport will be somewhat in excess of this limit, except in Tonawanda creek, owing to the fact that the area of the canal is not sufficient to pass the requisite quantity of water at half a mile per hour. The average area in the rock-cut is 587 square feet of water, which will discharge only 25,828 cubic feet per minute at a velocity of half a mile per hour. To discharge 30,000 cubic feet per minute, at the same velocity, would require an additional area of 95 square feet, to secure which would cost not less than $60,000. Such an expenditure is not now recommended, of course.

It is desirable, however, to clean out the rock cut to the grade represented on the profile, which will require the removal of about 20,000 cubic yards of material, earth and rock, and will cost $15,000. This will increase the average area to 588.3 square feet. The evil of too rapid a current has been obvious on this division for years past. It grows out of the enormous and entirely gratuitous waste of water which is allowed at many waste-weirs on the line and through several dry-docks.

It is impossible to supply this waste and maintain the canal at the same time without drawing the water through the prism at a high velocity, which seriously impedes western bound boats, and wears out their horses in the constant struggle to overcome its force. Even then the surface of the canal is frequently drawn down below its proper stage, especially in the dry season, when the demand for water outside of the canal becomes most pressing, resulting in the grounding of boats to their great injury when loaded, and with loss of much valuable time. The drain upon the canal, as is well known, is made for hydraulic purposes. The millers along the canal, from using merely the legitimate surplus after navigation is supplied, have come to insist that the canal shall have only the surplus after their mills are fully supplied. To accomplish this end, they do not hesitate to open the waste-gates whenever and to whatever extent it may suit their convenience to do so. Not only at night, and by stealth, but by day, and in the boldest manner, have they opened the gates and made way with the water to which they were in no wise entitled, for which they pay nothing to the State, and for lack of which the navigation of the canal suffers immeasurably.

So open a violation of the laws enacted to protect the interests of navigation could not go unpunished except by the connivance or neglect of the officers and subordinates to whom the care of the water of the canal is intrusted. The control of the water in the rock cut west of Lockport has largely passed into the hands of the Hydraulic Company there organized, which manages the flow without much regard to the interest of navigation. The float measurement before referred to indicated a velocity in the rock cut varying from 84.25 to 108.20 feet per minute, or from .96 to 1.23 (*say one and a-quarter*) *miles per hour*..

The velocity of current between Sulphur Spring and Lockport may be perfectly regulated. Whenever the creek is at a higher stage than the elevation given to it on the profile, the mitre-gates of the guard-lock should be closed, and the water passed through the sluice-gates or paddles, which have an area more than sufficient to supply the canal. The water may thus be controlled so as to keep it at its proper level just east of the guard-lock, and will flow at the velocity shown in the

table, unless it be unwarrantably drawn down to supply the race-ways at Lockport.

To prevent this the control of the gates at Lockport should be in the hands of a State officer, whose duty it should be to keep the water up to the regulation mark, *not* by increasing the flow indefinitely at Sulphur Spring, but by partially stopping the discharge at Lockport when necessary. It might be a better plan to establish submerged weirs across the raceways, so as to limit automatically the amount of water passing over them per minute.

The flow of water east of Lockport depends *first* upon the stage of the surface maintained at Lockport, and *second*, upon the quantity withdrawn from the canal at other points. The custom has been by raising the Lockport flush-board to keep a head of water at that point sufficient to compensate pretty generally for the losses taking place at points below, notably at Mabees, Johnson's creek, Middleport, Medina, Eagle Harbor, Albion, Brockport and Adam's basin. *The first step* toward remedying this evil is to correct the grade of the spillways, according to the elevations given in the table of waste-weirs, so that the automatic action of these regulators may be properly realized. *The second step* is to close, lock and firmly secure all waste-gates, putting the keys in charge of the superintendent, or some officer by him appointed instead of leaving them in the hands of those whose whole interest it is to have the gates open as is now the case. *The third step* is to organize and maintain, under strict discipline, a strong police force, whose duty it shall be to patrol the canal day and night, by reliefs, and promptly arrest and bring to conviction any person violating the law in respect to opening gates, or otherwise taking water from the canal. It will then be possible to keep the surface at Lockport at the proper hight, namely seven feet on the mitre-sill, and yet supply the canal perfectly at all points below.

It must be remembered that the millers on the canal, and for miles north of it on the streams fed from the canal, are now a powerful and wealthy class of citizens, and can afford, and will pay, large sums of money to prevent in some way the water power being taken from them, which they now enjoy illegitimately, without cost to themselves, but at the expense of the canal and canal business. Hence, nothing but the most energetic and stringent policy will succeed in abolishing this vast abuse, which, if allowed to grow a few years longer, will completely destroy the canal as a highway for navigation, and convert it into a simple mill-race, maintained at the expense of the State for the benefit of a privileged few.

A favorite method of securing immunity in the use of water by the millers has been to secure the appointment of their own men, *relatives*

and friends, to canal offices, an abuse which should be guarded against in the future, if the attempt to restore the canal to its legitimate uses and to protect the rights of those who pay toll upon it, is to be successfully accomplished.

REPAIRS OF CANAL.

The following estimates, based on the cross-sections of the survey, have been worked out, with considerable detail, and are sufficiently close for a general estimate:

They show that on this division there is required,

For bottoming out	$225,228 90
For repairing tow-path	54,711 10
For repairing berme	5,584 77
For repairing slope and vertical walls	32,074 00
Total	$317,598 77

The repair of tow-path and berme banks are considered to be of the first importance, as a precautionary measure against breaks. The repair of slope and vertical walls, and paving being incident thereto, should be done at the same time.

The portions of the canal most in need of bottoming out are:

From county line to lock 53	$8,115 80
From lock 54 to lock 55	5,773 25
From lock 59 to lock 60	13,031 20
From lock 61 to lock 62	17,950 10
Adam's Basin, stop-gate to Hulberton bridge	31,695 00
From Lockport to Pendleton	37,600 00
Total	$114,165 35

From Murphy's culvert to Pendleton the canal passes through a cutting in quicksand material, which has washed into the prism in large quantities, and has greatly injured the walls of the canal. Thorough improvement of this part of the canal will be essential to navigation, and cannot be postponed very long. No estimate has been made upon repairs of structures, as these can be made from time to time, by the officers in charge, independently of the repairs to prism and banks.

I desire to call attention, however, to the improvements required in *Sulphur Spring guard-lock*. There is but a single chamber for the lockage of boats, whereas all the other locks are now double-chambered, except the river lock at Tonawanda. The pier forming one side of this chamber is so narrow that the balance beam of the gate overhangs it

considerable, and it is impossible for the gate to be worked, except by ropes and pulleys. It is on this account that these gates are left open, when the stage of water in the creek renders it proper to close them, and hence a great volume of water is allowed to rush through the rock cut which should be kept back.

I propose that, until such time as it is thought best to double the lock, a platform be extended from the pier, supported by suitable braces, to enable the lock-tenders to operate the gates in the usual manner. This repair should be made this spring before the opening of navigation.

I have the honor to be, sir,

Very respectfully, your obedient servant.

WM. H. SEARLES,

Division Engineer.

Approximate estimate of work necessary to reduce the canal prism to grade, and raise tow-path and berme bank to required hight.

LOCALITY.	Distance, miles.	Quantities.	Items.	Price.	Amount.	Total amount.
From Wayne county line to lock 53, Clyde...	7.710	23,188	Cubic yards earth excavation	$0 35	$8,115 80	
		8,780	Cubic yards lining, T. P	50	4,390 00	
		7,400	Cubic yards embankment, berme	15	1,110 00	
		2,220	Cubic yards taking up and relaying pavement	90	1,998 00	
		771	Cubic yards slope wall	2 00	1,542 00	
						$17,155 80
Lock 53, Clyde, to lock 54, Berlin	3.158	13,737	Cubic yards earth excavation	35	$4,807 95	
		3,960	Cubic yards lining, T. P	50	1,980 00	
		2,700	Cubic yards embankment, berme	15	405 00	
		910	Cubic yards taking up and relaying pavement	90	819 00	
		316	Cubic yards slope wall	2 00	632 00	
						8,643 95
Lock 54 Berlin, to lock 55, Lyons	3.347	16,495	Cubic yards earth excavation	35	$5,773 25	
		3,580	Cubic yards lining, T. P	50	1,790 00	
		2,025	Cubic yards embankment, berme	15	303 57	
		1,040	Cubic yards taking up, etc., pavement	90	936 00	
		335	Cubic yards slope wall	2 00	670 00	
						9,472 82
Lock 55, Lyons, to lock 56, Poor-house	1.705	350	Cubic yards lining, T. P	50	$175 00	
		360	Cubic yards embankment, berme	15	54 00	
		210	Cubic yards taking up, etc., pavement	90	189 00	
		171	Cubic yards slope wall	2 00	342 00	
						760 00
Lock 56, Poor-house, to lock 57, Lockville	3.158	6,927	Cubic yards earth excavation	35	$2,424 45	
		1,650	Cubic yards lining, T. P	50	825 00	
		2,115	Cubic yards embankment, berme	15	317 25	
		580	Cubic yards taking up, etc., pavement	90	522 00	
		316	Cubic yards slope wall	2 00	632 00	
						4,720 70
Lock 59, Upper Lockville, to Lock 59, Lower Macedon	12.124	37,232	Cubic yards earth excavation	35	$13,031 20	
		15,533	Cubic yards lining, T. P	50	7,766 50	
		6,009	Cubic yards embankment, berme	15	901 35	
		3,400	Cubic yards taking up, etc., pavement	90	3,060 00	
		1,212	Cubic yards slope wall	2 00	2,424 00	
						27,183 05
Lock 60, Lower Macedon, to lock 61, Upper Macedon	0.827	1,689	Cubic yards earth excavation	35	$591 15	
		230	Cubic yards lining, T. P	50	115 00	
		312	Cubic yards embankment, berme	15	46 80	
		65	Cubic yards taking up, etc., pavement	90	58 50	
		83	Cubic yards slope wall	2 00	166 00	
						977 45

Lock 61 (U. Macedon), to lock 62 (Pittsford),	17.169	51,286	Cubic yards earth excavation	0 35	$17,950 10	
		3,591	Cubic yards lining, T. P	50	1,795 50	
		1,293	Cubic yards embankment, berme	15	193 95	
		1,300	Cubic yards taking up, etc., pavement	90	1,170 00	
		1,717	Cubic yards slope wall	2 00	3,434 00	
						24,543 55
Lock 62, to lock 63 (Miller's)	2.850	6,600	Cubic yards earth excavation	35	$2,310 00	
		3,300	Cubic yards lining, T. P	50	1,650 00	
		1,550	Cubic yards embankment, berme	15	232 50	
		900	Cubic yards taking up, etc., pavement	90	810 00	
		286	Cubic yards slope wall	2 00	572 00	
						5,574 50
Lock 63 to lock 64 (Sipple's)	0.533	133	Cubic yards lining, T. P	50	$66 50	
		50	Cubic yards taking up, etc., pavement	90	45 00	
		54	Cubic yards slope wall	2 00	108 00	
						219 50
Lock 64 to lock 65 (Reservoir)	0.383	80	Cubic yards lining, T. P	50	$40 00	
		78	Cubic yards embankment, berme	15	11 70	
		40	Cubic yards taking up, etc., pavement	90	36 00	
		38	Cubic yards slope wall	2 00	76 00	
						163 70
Lock 66, Rochester, to 4 mile grocery	5.775	9,000	Cubic yards earth excavation	35	$3,150 00	
		300	Cubic yards rock excavation	1 00	300 00	
		1,525	Cubic yards lining, T. P	50	762 50	
		1,873	Cubic yards embankment, berme	15	280 95	
		677	Cubic yards taking up and relaying pavement	90	609 30	
		578	Cubic yards slope wall	2 00	1,156 00	
						6,258 75
From 4 mile Grocery to Spencerport	7.650	31,600	Cubic yards earth excavation	35	$11,060 00	
		7,661	Cubic yards lining, T. P	50	3,830 50	
		1,561	Cubic yards embankment, berme	15	234 15	
		2,395	Cubic yards taking up, etc., pavement	90	2,146 50	
		765	Cubic yards slope wall	2 00	1,530 00	
						18,801 15
Spencerport to Cooley's Basin	5.225	23,000	Cubic yards earth excavation	35	$8,050 00	
		3,600	Cubic yards rock excavation	1 00	3,600 00	
		2,158	Cubic yards lining, tow-path	50	1,079 00	
		2,390	Cubic yards embankment, berme	15	358 50	
		979	Cubic yards taking up, etc., pavement	90	881 10	
		523	Cubic yards slope wall	2 00	1,046 00	
						15,014 60
From Cooley's Basin to McCarty's Bridge, Holley	7.400	28,300	Cubic yards earth excavation	35	$9,905 00	
		10,100	Cubic yards rock excavation	1 00	10,100 00	
		4,853	Cubic yards lining, tow-path	50	2,426 50	
		2,354	Cubic yards embankment, berme	15	353 10	
		1,420	Cubic yards taking up, etc., pavement	90	1,278 00	
		740	Cubic yards slope wall	2 00	1,480 00	
						25,542 60
From McCarty's Bridge to Hindsburgh	4.525	19,000	Cubic yards earth excavation	35	$6,650 00	
		4,800	Cubic yards rock excavation	1 00	4,800 00	
		1,977	Cubic yards lining, tow-path	50	988 50	

Approximate estimate, etc. — (Continued).

LOCALITY.	Distance, miles.	Quantities.	Items.	Price.	Amount.	Total amount.
From McCarty's bridge to Hindsburgh	4.525	866	Cubic yards embankment, berme	$0 15	$54 90	
		742	Cubic yards taking up, etc., pavement	90	667 80	
		453	Cubic yards slope-wall	2 00	906 00	
						$14,067 20
From Hindsburgh to Eagle Harbor	7.750	35,100	Cubic yards earth excavation	35	$12,250 00	
		1,100	Cubic yards rock excavation	1 00	1,100 00	
		3,700	Cubic yards lining, towpath	50	1,850 00	
		719	Cubic yards embankment, berme	15	107 85	
		1,090	Cubic yards taking up, etc., pavement	90	981 00	
		775	Cubic yards slope-wall	2 00	1,550 00	
						17,838 85
From Eagle Harbor to Medina aqueduct	7.075	29,500	Cubic yards earth excavation	35	$10,325 00	
		1,200	Cubic yards rock excavation	1 00	1,200 00	
		2,175	Cubic yards lining, towpath	50	1,087 50	
		981	Cubic yards embankment, berme	15	147 15	
		904	Cubic yards taking up, etc., pavement	90	813 60	
		708	Cubic yards slope-wall	2 00	1,416 00	
						14,989 25
From Medina aqueduct to Middleport waste weir	5.525	12,900	Cubic yards earth excavation	35	$4,515 00	
		100	Cubic yards rock excavation	1 00	100 00	
		1,047	Cubic yards lining, tow-path	50	523 50	
		654	Cubic yards embankment, berme	15	98 10	
		678	Cubic yards taking up, etc., pavement	90	610 20	
		553	Cubic yards slope-wall	2 00	1,106 00	
						6,952 80
From Middleport waste-weir to Orangeport,	6.150	14,300	Cubic yards earth excavation	35	$5,005 00	
		3,385	Cubic yards lining, tow-path	50	1,692 50	
		878	Cubic yards embankment, berme	15	131 70	
		1,090	Cubic yards taking up, etc., pavement	90	981 00	
		615	Cubic yards slope-wall	2 00	1,230 00	
						9,040 20
From Orangeport to Lockport locks	5.412	23,700	Cubic yards earth excavation	35	$8,295 00	
		1,488	Cubic yards lining, tow-path	50	744 00	
		1,615	Cubic yards embankment, berme	15	242 25	
		579	Cubic yards taking up, etc., pavement	90	521 10	
		542	Cubic yards slope-wall	2 00	1,084 00	
						10,886 35
From upper lock, Lockport, to Murphy's farm	2.750	16,700	Cubic yards earth excavation	40	$6,680 00	
		2,800	Cubic yards rock excavation	1 25	3,500 00	
						10,180 00

Murphy's farm to Sulphur Spring guard-lock	2.429	37,000	Cubic yards earth excavation	0 40	$14,800 00	
		1,900	Cubic yards rock excavation	1 25	2,375 00	
		243	Cubic yards vertical wall	4 00	972 00	
						18,147 00
From guard-lock to west end of T. P., over Tonawanda ck., at Pendleton	1.612	22,800	Cubic yards earth excavation	40	$9,120 00	
		900	Cubic yards rock excavation	1 25	1,125 00	
		4,000	Cubic yards vertical wall, taking up and relaying	2 00	8,000 00	
						18,245 00
From T. P. bridge, Pendleton, to Tonawanda dam	11.600	27,100	Cubic yards earth excavation	20	$5,420 00	
						5,420 00
From Tonawanda dam to guard-lock, Black Rock	7.900	67,200	Cubic yards earth excavation	40	$26,800 00	
						26,800 00
						$317,598 77

Recapitulation of estimate.

LOCALITY.	Earth excavation in prism.	Rock excavation in prism.	Tow-path lining and pavement.	Berme embankment.	Slope and vertical wall.
Wayne county line to lock 53	$8,115 80		$6,388 00	$1,110 00	$1,542 00
Lock 53 to lock 54	4,807 95		2,799 00	405 00	632 00
Lock 54 to lock 55	5,773 25		2,726 00	303 57	670 00
Lock 55 to lock 56			364 00	54 00	342 00
Lock 56 to lock 57	2,424 45		1,347 00	317 25	632 00
Lock 59 to lock 60	13,031 20		10,826 50	901 35	2,424 00
Lock 60 to lock 61	591 15		173 50	46 80	166 00
Lock 61 to lock 62	17,950 10		2,965 50	193 95	3,434 00
Lock 62 to lock 63	2,310 00		2,460 00	232 50	572 00
Lock 63 to lock 64			111 50		108 00
Lock 64 to lock 65			76 00	11 70	76 00
Lock 66 to Four Mile Grocery	3,150 00	$300 00	1,371 80	280 95	1,156 00
Four Mile Grocery to Spencerport	11,060 00		5,977 00	284 15	1,530 00
Spencerport to Cooley's Basin	8,050 00	3,600 00	1,960 10	358 50	1,046 06
Cooley's Basin to McCarty's Bridge	9,905 00	10,100 00	3,704 50	353 10	1,480 00
McCarty's Bridge to Hindsburgh	6,650 00	4,800 00	1,656 30	54 90	906 00
Hindsburgh to Eagle Harbor	12,250 00	1,100 00	2,831 00	107 85	1,550 00
Eagle Harbor to Medina aqueduct	10,325 00	1,200 00	1,901 10	147 15	1,416 00
Medina aqueduct to Middleport W. W.	4,515 00	100 00	1,133 70	98 10	1,106 00
Middleport W. W. to Orangeport	5,005 00		2,673 50	131 70	1,230 00
Orangeport to Lockport	8,295 00		1,265 10	242 25	1,084 00
Lockport to Murphy's farm	6,680 00	3,500 00			
Murphy's farm to Sulphur Spring	14,800 00	2,375 00			972 00
Sulphur Spring to Pendleton	9,120 00	1,125 00			8,000 00
Pendleton to Tonawanda dam	5,420 00				
Tonawanda dam to Black Rock	26,800 00				
	$197,028 90	$28,200 00	$54,711 10	$5,584 77	$32,074 00

SUMMARY.

1.° Earth excavation	$197,028 90
2.° Rock excavation	28,200 00
3.° Taking up and relaying pavement and lining	54,711 10
4. Embankment	5,584 77
5. Slope and vertical walls	32,074 00
Total for division	$317,598 77

Table of locks on the Western division, showing elevations, and lifts of grades and surfaces.

NUMBER OF LOCK.	Locality.	Distance.		Elevations above Lock.		Depth of water.	Elevations of Wall.		Elevation lower Mitre-Sill.	
		Chains.	Miles.	Upper grade.	Upper surface.		Old lock, tow-path.	New lock, berme.	Old lock, tow-path	New lock, berme.
Guard lock	Black Rock	1689.04	21.113	562.026	572.926	10.90	562.026	.....	560.806	.....
Guard lock	Sulphur Springs	414.32	5.179	559.986	568.986	9.00	559.334	.....	559.344	.....
Lock 71	Lockport	6.68	.084	559.067	568.567	9.50	558.253	.....	548.824	.....
Lock 70	Lockport	.....	.....	.....	.....	.....	.....	.....	537.638	.....
Lock 69	Lockport	.....	.....	.....	.....	.....	.....	.....	526.539	.....
Lock 68	Lockport	.....	.....	.....	.....	.....	.....	.....	515.470	.....
Lock 67	Lockport	4999.18	62.490	515.470	522.470	7.000	.....	.....	504.140	.....
Lock 66	Rochester	84.09	1.051	500.140	507.975	7.835	500.130	500.300	492.036	492.116
Lock 65	Reservoir	30.66	0.383	492.116	499.116	7.000	491.069	491.104	482.014	481.899
Lock 64	Sipple's	42.62	0.533	482.014	489.014	7.000	480.795	481.145	471.851	471.906
Lock 63	Miller's	227.98	2.850	471.906	478.906	7.000	471.129	471.099	463.104	463.124
Lock 62	Pittsford	1373.55	17.169	463.124	470.124	7.000	461.924	461.874	453.974	453.754
Lock 61	Macedon	66.20	0.827	453.974	460.974	7.000	453.622	453.562	447.373	447.298
Lock 60	Macedon	969.89	12.124	447.373	454.373	7.000	446.338	446.248	437.322	437 012
Lock 59	Lockville, upper	12.59	0.157	437.322	444.322	7.000	436.408	436.318	429.170	429.320
Lock 58	Lockville, middle	14.38	0.180	429.320	436.320	7.000	428.466	428.526	421.290	421.316
Lock 57	Lockville, lower	252.68	3.158	421.316	428.316	7.000	420.166	420.206	413.288	412.938
Lock 56	Poor-house	136.39	1.705	413.288	420.288	7.000	412.549	412.659	403.440	403.260
Lock 55	Lyons	267.79	3.347	403.440	410.440	7.000	402.909	402.348	397.169	397.189
Lock 54	Berlin	252.60	3.158	397.189	404.189	7.000	396.074	396.606	389.719	389.829
Lock 53	Clyde	616.84	7.710	389.829	396.829	7.000	389.288	389.356	335.155	384.925
	Wayne County Line	0.0	0.00	385.074	392.074	7.000	.....	.....	.....	.....
		11,457.48	143.218							

Table of locks on Western Division — (Continued).

NUMBER OF LOCK.	Locality.	ELEVATIONS BELOW LOCK.		Depth of water.	LIFTS OF.		Hollow quoin benches, elevation.	Position of benches.
		Lower grade.	Lower surface.		Grade.	Surface.		
Guard lock	Black Rock	560.806	569.806	6.00	1.220	3.120	557.677	On coping, west H. Q., south side.
Guard lock	Sulphur Spring	559.986	568.986	9.00	0.0	0.0	580.446	On coping, west H. Q., south side.
Lock 71	Lockport	.....	.....	7.000	10.248	12.743	569.631	On coping, west H. Q., south side.
Lock 70	Lockport	.....	.....	7.000	11.186	11.186	.....	
Lock 69	Lockport	.....	.....	7.000	11.099	11.099	.....	
Lock 68	Lockport	.....	.....	7.000	11.069	11.069	.....	
Lock 67	Lockport	503.140	511.140	8.000	12 330	11.330	523.877	On coping, west H Q., south side.
Lock 66	Rochester	492.116	499.116	7.000	8.024	8.859	510.197	On coping, west H. Q., south side.
Lock 65	Reservoir	481.014	489.014	7.000	10.102	10.102	500.878	On coping, west H. Q., south side.
Lock 64	Sipple's	471.906	478.906	7.000	10.108	10.108	490 813	On coping, west H. Q., south side.
Lock 63	Miller's	463.124	470.187	7.063	8.782	8.719	480.854	On coping, west H. Q., south side.
Lock 62	Pittsford	453.974	461.317	7.343	9.150	8.807	471.896	On coping, west H. Q., south side.
Lock 61	Macedon	447.373	454.373	7.000	6.601	6.601	466.277	On coping, west H. Q., south side.
Lock 60	Macedon	437.322	444.487	7.165	10.051	9.886	455.905	On coping, west H. Q., north side.
Lock 59	Lockville, upper	429.320	436.320	7.000	8.002	8.002	446.043	On coping, west H. Q., south side.
Lock 58	Lockville, middle	421.316	428.316	7.000	8.004	8.004	438.171	On coping, west H. Q., south side.
Lock 57	Lockville, lower	413.288	420.288	7.000	8.028	8.028	429.813	On coping, west H. Q., south side.
Lock 56	Poor-house	403.440	410.440	7 000	9.848	9.848	422.415	On coping, west H. Q., north side.
Lock 55	Lyons	397.189	404.189	7.000	6.251	6.251	412.114	On coping, west H. Q., north side.
Lock 54	Berlin	389.829	396.829	7.000	7.360	7.360	406.280	On coping, west H. Q., north side.
Lock 53	Clyde	385.074	392.074	7.000	4.755	4.755	399.034	On coping, west H. Q., north side.
	Wayne County Line	.....	.....	.....	.....	.....	.....	
					175.132	175.796		

Table of grades and surface descent, showing discharge in prism and loss of water at several points.

LOCALITY.	Station.	Distance.		Elevations.		Depth of water.	Fall of Grade.		Fall of Surface.		Total Fall.		Average surface width.
		Chains. L.	Miles. l.	Grade. G.	Surface. S.	d.	Per station.	Per mile.	Per station.	Per mile. f.	Grade.	Surface. F.	ft.
Black Rock	1689.04			560.806	569.806	9.00							
		629.14	7.864			9.00	.00100	.0800	.00100	.0800	.629	.629	88.26
Tonawanda	1059.90			560.177	569.177	9.00							
		1059.90	13.248			9.00	.00018	.0144	.00018	.0144	191	.191	200.00
Sulphur Spring	414.32=0.0			559.986	568.986	9.00							
		195.58	2.445			9.25	.00335	.2680	.00080	.0640	.657	.157	90.42
Murphy's.	218.74			559.329	568.829	9.50							
		218.74	2.734			9.50	.00120	.0960	.00120	.0960	.262	.262	68.27
Lockport	0.00			559.067	568.567	9.50							
Lockport	4999.18			503.140	511.140	8.000							
		499.18	6.24			7.937	.0006	.048	.00085	.068	.300	.425	96.45
Gasport	4500.			502.840	510.715	7.875							
		500.	6.25			7.825	.0006	.048	.00080	.064	.300	.400	97.70
Middleport	4000.			502.540	510.315	7.775							
		500.	6.25			7.737	.0006	.048	.00075	.060	.300	.375	93.38
Medina	3500.			502.240	509.940	7.700							
		500.	6.25			7.662	.0006	.048	.00075	.060	.300	.375	90.76
Eagle harbor	3000.			501.940	509.565	7.625							
		500.	6.25			7.600	.0006	.048	.00070	.056	.300	.350	87.96
Hindsburgh	2500.			501.640	509.215	7.575							
		500.	6.25			7.575	.0006	.048	.00060	.048	.300	.300	84.85
Holley	2000.			501.340	508.915	7.575							
		500.	6.25			7.575	.0006	.048	.00060	.048	.300	.300	80.95
Cooley's basin	1500.			501.040	508.615	7.575							
		500.	6.25			7.600	.0006	.048	.00050	.040	.300	.250	82.22
Spencerport	1000.			500.740	508.365	7.625							
		500.	6.25			7.662	.0006	.048	.00045	.036	.300	.225	81.01
Wide water	500.			500.440	508.140	7.700							
		500.	6.25			7.762	.0006	.048	.00035	.028		.165	73.50
Lock 66	0.00			500.140	507.975	7.835							
Lock 63	227.98			463.124	470.187	7.063							
		227.98	2.850			7.031	.00	.00	.00080	.023		.063	78.91
Lock 62	0.0			463.124	470.124	7.000							
Lock 62	1378.55			453.974	461.317	7.343							
		1378.55	17.169			7.172			.00080	.024		.343	71.80
Lock 61	0.00			453.974	460.974	7.000							
Lock 60	969.89			437.322	444.487	7.165							
		969.89	12.124			7.082			.00019	.0149		.165	72.17
Lock 59	0.0			437.322	444.322	7.000							

Table of grades, etc. — (Continued).

LOCALITY.	Station.	Average area in sq. feet. A.	Average perimeter. p.	Average ratio. R.	Average mean vel. ft. per min. V.	Average mean vel. miles per hour.	Aver'ge discharge cub. ft. per min. D.	Loss of Water.			Locality of weirs.
								Total cubic ft. per min.	By evapor'n & filtration.	By waste-weirs.	
Black Rock	1689.04						38,520				
		656.00	96.86	6.7727	51.056	.580	37,773	1,494	1,494		
Tonawanda	1059.90						36,926			0.0	Tonawanda.
		1800.00	205.00	8.7811	21.282	.242	38,308				
Sulphur Spring	414.32 = 0.0						35,778				
		750.00	101.00	7.4257	47.394	.538	35,546	338	338		
Murphy's	218.74						35,440				
		587.00	77.44	7.5801	60.196	.684	35,335	210	210		
Lockport	0.00						35,230				
								1,475		1,475	Lockport.
Lockport	4999.18						33,755				
		698.68	105.89	6.5511	45.678	.519	31,686	2,069	594	1,475	Lockport.
Gasport	4500.						31,092	594	594		
		680.69	101.05	6.7303	44.807	.509	30,474	618	594	24	Mabee's.
Middleport	4000.						28,100	2,374	594	{ 322	Johnson's creek.
		642.14	96.74	9.6377	42.834	.487	27,506	594	594	{ 1,458	Middleport.
Medina	3500.						25,867	1,639	594	1,045	Medina.
		603.04	94.357	6.3912	41.908	.476	25,273	594	594		
Eagle harbor	3000.						24,154	1,119	594	525	Eagle harbor.
		572.91	91.66	6.2504	39.748	.451	22,772	1,382	594	788	Albion.
Hindsburgh	2500.						22,178	594	594		
		575.98	89.10	6.4644	37.042	.421	21,335	843	594	249	Brockville.
Holley	2000.						19,024	2,311	594	1,717	Holley.
		514.68	84.32	6.1039	35.809	.407	18,430	594	594		
Cooley's basin	1500.						17,228	1,142	594	548	Brockport.
		511.41	83.43	6.1299	33.202	.366	16,468	820	594	226	Adam's basin.
Spencerport	1000.						15,874	594	594	0.0.	Spencerport.
		518.77	84.86	6.1133	30.164	.343	15,280	594	594		
Wide water	500.						14,686	594	594		
		509.33	77.81	6.5464	26.958	.306	14,092	594	594		
Lock 66	0.00						12,175	1,917	594	1,323	Rochester.
								306	306		
Lock 63	227.98						11,869				
		517.00	82.87	6.2385	22.447	.255	11,605	264	221	43	Brighton.
Lock 62	0.0						11,384	221	221		
Lock 62	1373.55						11,384				
		435.00	74.66	5.8293	22.729	.258	9,860	1,524	1,330	194	Cartersville.
Lock 61	0.00						8,503	1,357	1,330	27	Fairport.
								128	128		
Lock 60	969.89						8,375				
		445.00	76.58	5.8109	16.492	.187	7,339	1,036	940	96	Palmyra aqued't.
Lock 59	0.0						6,154	1,185	940	245	Newark.

Table of waste weirs, showing loss of water, etc.

Above lock No.	Station.	LOCALITY.	Elevation of grade.	Elevation of surface.	Elevation of present weir.	Head on weir.	Length of weir.	Loss of water cu. ft. per min.	Proper elevation of weir.	Proper head.	Proper loss cu. ft. per min.
S. S. G. lock	1101	Tonawanda	560.218	569.218	(F. B) 569.483	None.	154.5	None.	569.483	None.	
66	4976	State race									
66	4966	Lockport	503.120	511.111	510.546	.565	60.	[3,948]			
	4966	Lockport flush board		511.111	511.218	None.			510.891	.220	912
	4964	Lockport	503.120	511.111	510.675	.436	37.	[1,654]			
	4964	Lockport flush board		511.111	511.242	None.			510.891	.220	563
66	4422	Mabee's	502.793	510.653	510.296	.357	33.	1,034	510.431	.222	513
66	4201	Johnson's creek	502.661	510.446	510.076	.390	15.	557	510.244	.222	233
66	4075	Middleport	502.585	510.375	509.968	.407	57.	2,279	510.153	.222	887
		Middleport gates	502.585	510.375	509.981	.394	11.	422	510.153	.222	171
66	3639	Medina	503.324	510.045	509.628	.417	51.	2,120	509.835	.210	720
		Medina gates	502.324	510.045	?	?	23.	?	509.835	.210	325
66	3041	Eagle Harbor	501.964	509.595	508 935	.660	39.	3,132	509.392	.203	525
		Eagle Harbor gates	501.964	509.595	?	?	7.5	?	599.392		
66	2764	Albion	501.804	509.404	509.154	.250	60.	1,119	509.204	.200	788
		Albion gates			510.282	None.	32.		509.204		
66	2370	Brockville	501.562	509.137	509.940	None.	14.		508.955	.182	158
		Brockville gates	501.562	509.137	509.190	None.	8.		508.955	.182	91
66	2016	Holley (old)	501.350	508.925	508.684	.241	68.	1,208	508.684	.241	1,208
		Holley gate	501.350	508.925					508.684		
66	2005	Holley (new)	501.343	508.918	508.709	.209	15.75	[222]	508.684		
		Holley flush board	501.343	508.918	508.891	.027	15.75	8	508.568	.350	514
66	1693	Brockport, West	501.156	508.731	508.188	.543	18.	[1,168]			
		Brockport gates	501.156	508.731	508.176	.555	16.33	[1,095]			
		Brockport east	501.156	508.731	508.221	.510	16.50	[958]			
		Brockport flush board	501.156	508.731	508.563	.168	20.83	500	508.553	.178	548
66	1310	Adam's Basin west F. B.	500.926	508.520	507.946	.574	7.	469	508.344	.176	75
		Adam's Basin gates	500.926	508.520	508.056	464	8.	397	508.344	.176	86
		Adam's Basin east F. B.	500.926	508.520	507.986	.534	6.	367	508.344	.176	65
66	1034	Spencerport	500.760	508.383	508.146	.237	4.	66	508.383	0.000	0
66	101	Rochester spillway	500.205	508.010	507.856	.154	60.	1,083	507.856	.154	1,083
66	131	Rochester aqueduct gates	500 205	508.010							
66	102	Rochester weigh-lock	500.205	508.010							240
65	3	Reservoir	492.116	499.116	500.501	None.	14.20	0	499.016	.100	60
62	100	Brighton	463.124	470.154	470.011	.143	7.50	57	470.032	.122	43
61	1094	Cartersville	453.974	461.302	460.965	.337	40.	1,171			194
61	626	Fairport	453.974	461.162	461.100	.062	14.	27	461.100	.062	27
59	818	Palmyra aqueduct	437.322	444.478	444.307	.171	72.	736	444.426	.052	96
59	67	Newark	437.322	444.335	444.232	.103	40.	177	444.208	.127	245
58	3	Lockville	429.330	436.320	436.606	None.	20.	0	435.990	.330	565
55	35	Lyons aqueduct	403.440	410.440	410.423	.017	100.	26	410.423	.017	26
54	195	Lyons	397.189	401.189	404.275	None.			404.189	.000	0
53	208	Berlin	389.829	396.829	397.069	None.	11.		396.829	.000	0
Co. line	609	Clyde	385.074	392.074	?	?	11.	?	392.074	.000	0

Table of waste weirs, showing loss of water, etc. — (Continued).

Above lock No.	Station.	LOCALITY.	Valves.		Total area wide open.	Mean head	Total discharge of valves, cu. ft. per min	Elevation of bench.	Location of bench.
			No.	Size.					
S. S. G lock..	1101	Tonawanda	....	None	.....	.....	None	578.194	Bouck street bridge, west wing.
66	4976	State race	...	Tn'k 4 x 6	24	16	20,000	.....	
66	4966	Lockport	3	5½ x 2	28.20	6.49	21,455	516.625	East abutment, berme side.
	4966	Lockport flush board	....	.....	.....	.....	.....	.....	
	4964	Lockport	3	5½ x 4	66	6.5	(not used)	.....	
	4964	Lockport flush board	...	.....	.....	.....	.....	.....	
66	4422	Mabees	5	2½ x 2	25	7.8	20,842	512.892	West abutment, berme side.
66	4201	Johnson's creek	4	2½ x 2	20	7.8	16,666	513.476	
66	4075	Middleport	....	.....	.....	.....	.....	513.465	East abutment, berme side.
		Middleport gates	5	2½ x 2	25	7.8	20,842	.....	
66	3639	Medina	....	.....	.....	.....	.....	512.805	East wall, berme.
		Medina gates	5	3½ x 4	70	7.7	57,939	.....	
66	3041	Eagle Harbor	....	.....	.....	.....	.....	511.270	West wall.
		Eagle Harbor gates	3	3 x 3	27	7.6	22,194	.....	
66	2764	Albion	....	.....	.....	.....	.....	512.211	West abutment.
		Albion gates	6	2½ x 2	30	7.6	24,660	.....	
66	2370	Brockville	..	.....	.....	.....	.....	511.953	West abutment.
		Brockville gates	4	2½ x 2	20	7.5	16,331	.....	
66	2016	Holley (old)	....	.....	.....	.....	.....	511.686	West abutment, old.
		Holley gate	1	2 x 3	6	7.5	4,900	.....	
66	2005	Holley (new)	4	2 x 3	24	7.5	19,600	511.634	West abutment, new.
		Holley flush board	....	.....	.....	.....	.....	.....	
66	1693	Brockport west	....	.....	.....	.....	.....	.....	
		Brockport gates	3	2½ x 2	15	7.5	12,248	.....	
		Brockport east	..	.....	.....	.....	.....	510.338	East pier.
		Brockport flush board	....	.....	.....	.....	.....	.....	
66	1310	Adam's Basin, west F. B.	....	.....	.....	.....	.....	.....	
		Adam's Basin gates	4	2½ x 2	20	7.6	16,440	.....	
		Adam's Basin, east F. B.	...	.....	.....	.....	.....	511.372	East abutment.
66	1034	Spencerport	2	2½ x 2	10	7.6	8,220	509.846	East abutment.
66	101	Rochester spillway	....	0	.....	.....	.....	509.778	East end weigh-lock pier.
66	131	Rochester aqueduct gates	4	2 feet dia.	12.57	7.3	13,223	509.812	West end of aqueduct, north side.
66	102	Rochester weigh-lock	2	5½ x 2	14.10	7.6	11,590	509.778	East end weigh-lock pier.
65	3	Reservoir	4	355 x 1.5	21.30	0.85	6,667	500.878	E. H. Q., lock 65.
62	100	Brighton	3	2½ x 2	15	6.5	11,400	472.285	N. east wing.
61	1094	Cartersville	5	2½ x 2	25	6.5	19,000	462.959	West tow-path abutment.
61	626	Fairport	3	2½ x 2	15	6.5	11,400	465.715	T. P. parapet.
59	818	Palmyra aqueduct	5	3½ x 2	35	6.0	25,650	446.248	West wing, south side.
59	67	Newark	5	2½ x 2	25	6.5	19,000	446.422	West abutment, north side.
58	3	Lockville	0	0	.....	.....	0	438.171	E. H. Q., lock 58.
55	85	Lyons aqueduct	5	3½ x 2	35	6.0	25,650	412.551	West wing abutment.
54	195	Lyons	5	2½ x 2	25	6.5	19,000	.....	
53	208	Berlin	3	2½ x 2	15	6.5	11,400	398.917	West abutment.
Co. line	609	Clyde	2	2½ x 3½	17.5	6.5	13,366	.....	

Table of benches — Elevations finally corrected.

DESCRIPTION.	Station.	Elevation by survey.	Correction for tests.	Correction for eastern and middle division.	Probable elevation.	Probable error.	Difference between benches.	Probable error in differences.
County line bridge	0.	395 538	.....	.....	396.978	.....	.....	.....
Pitt lock bridge	134.33	395.499	.....	.....	396.939	.....	— 0.039	.....
Bridge four miles west of county line	320.96	395.674	.....	.....	397.114	.....	+ 0.175	.....
Railroad bridge	358.79	395.404	.....	.....	396.844	.....	— 0.270	.....
Syc. tree, three chains west of toll-gate	413.	391.002	.....	.....	392.442	.....	— 4.402	.....
Glasgow street bridge, Clyde	516.55	394.599	.....	.....	396.039	.....	+ 3.597	.....
East berme, hollow quoin, Lock 53	0.	397.509	.....	+1.525	399.034	.....	+ 2.995	.....
Bridge, west wing, berme side	9.	400.001	—.001	+1.525	401.525	.000	+ 2.491	.000
Barker's bridge, east wing, tow-path	73.	399 923	+.114	+1.525	401.462	.007	— 0.063	.007
Long's bridge, east wing, berme side	130.	400.750	—.012	+1.525	402.263	.006	+ 0.801	.013
Center of culvert parapet, tow-path	194.	392.309	+.017	+1.522	393.851	.008	— 8.412	.014
West abutment waste-weir, berme	208.	397.376	+.016	+1.525	398.917	.008	+ 5.066	.010
Center of culvert parapet, tow-path	230.	392.290	+.015	+1.525	393.830	.007	— 5.087	.004
East berme, hollow quoin, Lock 54, Lock Berlin	252.	404.729	+.026	+1.525	406.280	.012	+12.450	.005
Bridge, east wing, berme	31.	407.161	+.040	+1.525	408.726	.010	+ 2.446	.005
Goetzman's bridge, east wing, berme	70.	408.014	+.059	+1.525	409.598	.014	+ 0.872	.005
Klaus' bridge, west wing, tow-path	125.	407.251	+.070	+1.525	408.846	.019	— 0.752	.005
Richmond's bridge, west wing, berme	152.	407.114	+.070	+1.525	408.709	.019	— 0.137	.000
Highway bridge, west wing, tow-path	177.	407.065	+.047	+1.525	408.637	008	— 0.072	.012
Center of arch culvert parapet, tow-path	197.	400.865	+.033	+1.525	402.423	.000	— 6.214	.007
Geneva street bridge, Lyons, west wing, tow-path	245.	707.900	+.033	+1.525	409.458	.000	+ 7.035	.000
Water street bridge, Lyons, east wing, tow-path	258.	405.978	+.040	+1.525	407.543	.004	— 1.915	.004
East berme, hollow quoin, Lock 55, Lyons	267.	410.551	+.038	+1.525	412.114	.002	+ 4.571	.001
Lyons Mud creek aqueduct, west wing buttress	36.	410.969	+.057	+1 525	412.551	.003	+ 0.437	.005
Prime's bridge, west wing, berme	100.	414.100	+.056	+1.525	415.681	.010	+ 3.130	.004
Highway bridge, east wing, tow-path, east of Lock 56,	130.	414.952	+.074	+1.525	416.551	.010	+ 0.870	.005
East berme, hollow quoin, Lock 56, Poor-house	136	420.818	+.072	+1.525	422.415	.012	+ 5.864	.000
Center culvert parapet, tow-path	41	415.347	+.081	+1.525	416.953	.012	— 5.462	.003
Moshier's bridge, west wing, tow-path	80.	423.272	+.079	+1.525	424.876	.011	+ 7.923	.001
Center culvert parapet, tow-path	100.	415.136	+.071	+1.525	416 732	.008	— 8.144	.004
Railroad bridge, east wing, tow-path, bottom step	150.	423.035	+.064	+1.525	424.624	.005	+ 7.892	.003

Table of benches — (Continued).

DESCRIPTION.	Station.	Elevation by survey.	Correction for tests.	Correction for eastern and middle division.	Probable elevation.	Probable error.	Difference between benches.	Probable error in differences.
Change bridge, west wing, tow-path	166.	423.941	+.052	+1.525	425.518	.001	+ 0.894	.006
Center of culvert parapet, tow-path	212.	415.936	+.047	+1.525	417.508	.003	— 8.010	.002
East berme, hollow quoin, Lock 57, Lockville	252.	428.237	+.051	+1.525	429.813	.002	+12.305	.002
East berme, hollow quoin, Lock 58, Lockville	14.	436.601	+.045	+1.525	438.171	.005	+ 8.358	.003
East berme, hollow quoin, Lock 59, Lockville	12.	444.483	+.035	+1.525	446.043	.010	+ 7.872	.005
Charles street bridge, east wing, tow-path, Newark	39.	445.997	+.062	+1.525	447.584	.004	+ 1.541	.014
Main street bridge, west wing, tow-path, Newark	52.	446.829	+.045	+1.525	448.399	004	+ 0.815	.008
Waste weir, west abutment, tow-path	67.	444.834	+.063	+1.525	446.422	.004	— 1.977	.009
Highway bridge, east wing, tow-path	142.	447.504	+.057	+1.525	449.086	.002	+ 2.664	.003
Peek's bridge, west wing, tow-path	192.	446.986	+.042	+1.525	448.553	.006	— 0.533	.008
Sweezy's bridge, west wing, tow-path	244.	447.752	+.055	+1.525	449.332	.000	+ 0.779	.006
Palmer's bridge, east wing, tow-path	280.	447.377	+.045	+1.525	448 947	.005	— 0.385	.005
Bridge, west wing, tow-path, Port Gibson	323.	447.175	+.042	+1.525	448.742	.007	— 0.205	.002
Highway bridge, east wing, tow-path, bottom step	527.	447.650	+.043	+1.525	449.218	.006	+ 0.476	.000
Center of culvert parapet, tow-path	666.	432.675	+.044	+1.525	434.244	.006	—14.974	.001
Highway bridge, west wing, berme, Palmyra	710.	449.267	+.090	+1.525	450.882	.004	+16.638	.007
Church street bridge, east wing, tow-path, Palmyra	748.	445.680	+.058	+1.525	447.263	.019	— 3.619	.015
Change bridge, east wing, north side	804.	446.637	+.094	+1.525	448.256	.020	+ 0.993	.012
Palmyra, Mud creek aqueduct, west wing buttress	819.	444.655	+.068	+1.525	446.248	.020	— 2.008	.008
Highway bridge, east wing, tow-path	853.	448.071	+.065	+1.525	449.661	.022	+ 3.413	.002
Clark's bridge, east wing, tow-path	878.	448.426	+.061	+1.525	450 012	.024	+ 0.351	.002
Highway bridge, east wing, tow-path	950.	447.552	+.056	+1.525	449.133	.026	— 0.879	.002
East berme, hollow quoin, Lock 60, Macedon	969.	454.323	+ 057	+1.525	455.905	.025	+ 6.772	.001
Change bridge, east wing, north side	32.	457.257	+.045	+1.525	458.827	.024	+ 2.922	.005
East berme, hollow quoin, Lock 61	66.	464.689	+.063	+1.525	466.277	.015	+ 7.450	.009
Highway bridge, west wing, tow-path	13.	466.113	+.069	+1.525	467.707	.012	+ 1.430	.003
Frear's bridge, west wing, tow-path	94.	463.922	+.073	+1.525	465.520	.009	— 2.187	.002
....	184.	463.491	+.057	+1.525	465.073	.017	— 0.447	.008
Highway bridge, west wing, tow-path, Wayneport	266.	463.371	+.069	+1.525	464.965	.011	— 0.108	.006
Snubbing post	387.40	463.060	+.042	+1.525	464.627	.025	— 0.338	.014
Knappville bridge, east wing, tow-path	451.	465.432	+.072	+1.525	467.029	.010	+ 2.402	.015

Center parapet cop., Thomas creek culvert	533.40	459.156	+.089	+1.525	460.770	.003	— 6.259	.006
Brown's bridge, east wing, tow-path	586.	465.421	+.062	+1.525	467.008	.001	+ 6.238	.006
Fairport waste-weir parapet, tow-path	626.	464.108	+.082	+1.525	465.715	.002	— 1.293	.007
Main street bridge, west wing, tow-path, Fairport	636.	464.825	+.082	+1.525	466.482	.000	+ 0.717	.001
Fulham basin's bridge, east wing, tow-path	713.	463.875	+.099	+1.525	455.499	.008	— 0.933	.009
Snubbing post	768.	462.971	+.086	+1.525	464.582	.002	— 0.917	.007
North-west corner culvert parapet, tow-path	830.	451.549	+.084	+1.525	453.158	.000	—11.424	.001
Wapping bridge, east wing, tow-path	834.	462.506	+.097	+1.525	464.128	.007	+10.970	.006
Wilsey bridge, east wing, berme	863.	463.811	+.068	+1.525	465.404	.007	+ 1.276	.002
Stop-gate, east end of recess, tow-path	924.	462.582	+.043	+1.525	464.150	.008	— 1.254	.004
Snubbing post	940.50	463.320	—.011	+1.525	464.834	.013	+ 0.684	.004
Bushnell's basin bridge, east wing, tow-path	951.	464.275	+.015	+1.525	465.815	.012	+ 0.981	.000
Paving stone, tow-path—+	1041.	461.525	+.022	+1.525	463.082	.016	— 2.733	.003
Cartersville bridge, west wing, tow-path	1080.	464.426	+.023	+1.525	465.974	.016	+ 2.892	.000
Cartersville waste-weir, west abutment, tow-path	1092.	461.377	+.057	+1.525	462.959	.016	— 3.015	.000
Guernsey's bridge, west wing, tow-path	1131.	465.939	+.061	+1.525	467.525	.018	+ 4.566	002
Highway bridge, east wing, tow-path, Pittsford	1171.	464.459	+ 051	+1.525	466.035	.013	— 1.490	.005
Main street bridge, east wing, tow-path, Pittsford	1194.	464.429	+.041	+1.525	465.995	.009	— 0.040	.005
State road bridge, Sutherland's, E. W. T. P., Pittsford,	1230.	464.270	+.047	+1.525	465.842	.011	— 0.153	.003
Crook's highway bridge, east wing, tow-path	1352.	464.152	+.003	+1.525	465.670	.012	— 0.172	.007
East berme, hollow quoin, Lock 62, Pittsford	1373.	470.357	+.014	+1.525	471.896	.012	+ 6.236	.002
Weed's bridge, east wing, tow-path	38.	472.462	+.016	+1.525	474.003	.014	+ 2.107	.001
Billinghurst's bridge, east wing, tow-path	78.	473.975	+.051	+1.525	475.551	.014	+ 1.548	.006
East abutment waste-weir, berme	99+70	470.686	+.074	+1.525	472.285	.013	— 3.266	.001
Donnelly's bridge, east wing, tow-path	141.	473.826	+.121	+1.525	475.472	.012	+ 3.187	.001
Hunt's bridge, east wing, tow-path	197.	473.732	+.167	+1.525	475.424	.012	— 0.048	.004
East berme, hollow quoin, Lock 63, Miller's	228.	479.138	+.191	+1.525	480.854	.013	+ 5.430	.004
Brighton bridge, east wing, tow-path	22.	482.911	+.203	+1.525	484.639	.014	+ 3.785	.003
East berme, hollow quoin, Lock 64, Sipple's	42.62	489.096	+.192	+1.525	490.813	.014	+ 6.174	.003
East berme, hollow quoin, Lock 65.	30.66	499.158	+.195	+1.525	500.878	.016	+10.065	.002
Monroe street bridge, west wing, tow-path	74.	501.344	+.202	+1.525	503.071	.019	+ 2.193	.003
East berme, hollow quoin, Lock 66	84.09	508.510	+.162	+1.525	510.197	.022	+ 7.126	.003
Goodman street bridge, east wing, tow-path	23 60	511.485	+.165	+1.525	513.175	.024	+ 2.978	.002
Averill street bridge, west wing, tow-path	53.20	512.277	+.175	+1.525	513.977	.029	+ 0.802	.005
Alexander street bridge, east wing, tow-path	60.88	511.521	+.139	+1.525	513.185	.031	— 0.792	.002
Griffith street bridge, west wing, tow-path	93.38	510.295	+.129	+1.525	511.949	.027	— 1.236	.005
East end weigh-lock pier	102.	508.126	+.127	+1.525	509.778	.026	— 2.171	.001
West end aqueduct, berme side	129.	508.162	+.125	+1.525	509.812	.026	+ 0.034	.001
Ford street bridge, east wing, tow-path, third step	172.	510.918	+.131	+1.525	512.574	.030	+ 2.762	.004

Table of benches — (Continued).

DESCRIPTION.	Station.	Elevation by survey.	Correction for tests.	Correction for eastern and middle divisions.	Probable elevation.	Probable error.	Difference between benches.	Probable error in differences.
Railroad bridge, east wing, tow-path, first step	243.44	510.121	+ .132	+1.525	511 778	.030	— 0.796	.000
Stop gate between hollow quoins, tow-path	308.50	507.248	+ .065	+1.525	508.838	.038	— 2.940	.005
Rowe street bridge, east wing, tow-path	352.53	511.888	+ .072	+1.525	513.485	.041	+ 4.647	.003
Change bridge, east wing, south side	368.02	510.112	+ .076	+1.525	511.713	.044	— 1.772	.002
Scott's bridge, east wing, tow-path	418.24	511.408	+ .060	+1.525	512.993	.046	+ 1.280	.006
Four Mile Grocery bridge, east wing, tow-path	461.22	512.141	+ .057	+1 525	513.723	.045	+ 0.730	.002
Snubbing post	556.30	509.991	+ .061	+1.525	511.577	.047	— 2.146	.002
Speir's bridge, east wing, tow-path	618.60	512.002	+ .068	+1.525	513.595	.050	+ 2.018	.003
Six Mile Grocery bridge, east wing, tow-path	640.34	512.161	+ .069	+1.525	513.755	.051	+ 0.160	.000
Douglas bridge, west wing, tow-path	691.60	510.487	+ .051	+1.525	512.063	.050	— 1.692	.006
Culvert parapet, tow-path	724.38	500.599	+ .051	+1.625	502.175	.049	— 9.888	.003
Henpeck bridge, east wing, tow-path	766.85	511.780	+ .024	+1.525	513 329	.049	+11.154	.009
Cromwell bridge, east wing, tow-path	855.20	512.396	+ .024	+1.525	513.945	.049	+ 0.616	.000
Arch culvert parapet, tow-path	899.	499.556	+ .011	+1.525	501.092	.047	—12.853	.004
Kilborn's bridge, east wing, tow-path	940.62	511.210	— .003	+1.525	512.732	.046	+11.640	.004
Norman's bridge, east wing, tow-path	1013.17	511.360	— .016	+1.525	512.869	.048	+ 0.137	.001
Spencerport waste-weir, east wall berme	1033.90	508.346	— .025	+1.525	509.846	.046	— 3.023	.004
Arch culvert parapet, tow-path	1048.33	500.418	— .032	+1.525	501.911	.043	— 7.935	.002
Amity st. bridge, Spencerport W. W. T. P. bot. step	1073.45	511.577	— .008	+1.525	513.094	.052	+11.183	.010
Snubbing post	1108.	511.947	— .061	+1.525	513.411	.054	+ 0.317	.002
Arch culvert parapet, tow-path	1115.56	499.162	— .058	+1.525	500.629	.054	—12.782	.001
Webster's bridge, east wing, tow-path	1154.60	512.789	— .044	+1.525	514.270	.054	+13 641	.004
Webster's west bridge, east wing, tow-path	1182.42	511.283	— .046	+1.525	512.762	.053	— 1.508	.001
Cressy's bridge, west wing, tow-path	1264.30	512.232	— .068	+1.525	513.689	.051	+ 0.927	.006
Adams' basin bridge, east wing, tow-path	1291.35	511.824	— .030	+1.525	513.319	.050	— 0.370	.001
Adams' basin waste-weir, east wall berme	1309.10	509.897	— .050	+1.525	511.372	.050	— 1.947	.001
Arch culvert parapet, tow-path	1309.62	500.655	— .030	+1.525	502.150	.050	— 9.222	.000
Stop gate near east hollow quoin, berme	1355.51	508.034	— .014	+1.525	509.545	.050	+ 7.395	.000
Doty's bridge, east wing, berme	1377.	513.191	+ .004	+1.525	514.720	.050	+ 5.175	.001
Dive culvert parapet, tow-path	1413.66	506.315	+ .007	+1.525	507.847	.051	— 5.291	.003
Brockway bridge, west wing, tow-path	1462.25	510 712	+ .008	+1 525	512 245	.051	+ 4.398	.000

Cooley's basin bridge, east wing, tow-path	1486.85	512.416	+.004	+1.525	513.945	.049	+ 1.700	.002
Dive culvert parapet, tow-path	1520.22	504.890	+.003	+1.525	506.418	.048	— 7.527	.001
Nail in snubbing post, tow-path	1574.	511.139	—.007	+1.525	512.657	.044	+ 6.239	.005
Dive culvert parapet, tow-path	1581.44	500.491	—.007	+1.525	502.009	.042	—10.648	.003
Snubbing post	1640.	510.411	—.019	+1.525	511.917	.038	+ 9.908	.003
Mechanic street bridge, Brockport, east wing, tow-path,	1654.76	509.602	—.014	+1.525	511.113	.035	— 0.804	.004
Smith street bridge, Brockport, east wing, tow-path	1691.76	511.464	—.018	+1.525	512.971	.033	+ 1.858	.002
Brockport waste-weir	1692.60	508.831	—.018	+1.535	510.338	.033	— 2.633	.000
Snubbing post	1703.90	510.959	—.033	+1.525	512.451	.033	+ 2.113	.001
Dive culvert parapet, tow-path	1840.42	501.780	+.002	+1.525	503.307	.037	— 9.144	.005
Miner's bridge, east end, foundation off-set, tow-path	1899.43	509.544	+.059	+1.525	511.128	.036	+ 7.821	.000
Dive culvert parpet, tow-path	1922.98	500.614	+.028	+1.525	502.167	.035	— 8.961	.009
Snubbing post	1955.80	512.641	+.020	+1.525	514.186	.031	+12.019	.004
Stop-gate, east of Holley	1990.	508.756	+.026	+1.525	510.307	.030	— 3.879	.003
Orr bridge, west wing, tow-path	1994.42	514.383	+.026	+1.525	515.934	.030	+ 5.627	.000
Holley waste-weir, west wing	2005.15	510.087	+.022	+1.525	511.634	.026	— 4.300	.002
Holley waste-weir, old canal	2008.	510.139	+.022	+1.525	511.686	.026	+ 0.052	.000
Holley bridge, east wing, tow-path	2031.50	513.851	+.013	+1.525	515.118	.024	+ 3.432	.004
Arch culvert parapet, west wing, tow-path	2054.20	501.289	+.022	+1.525	502.836	.025	—12.282	.002
Snubbing post, tow-path	2057.50	510.913	+.017	+1.525	512.455	.024	+ 9.619	.001
McCarty's bridge, east wing, tow-path	2085.32	513.851	+.026	+1.525	515.402	.024	+ 2.947	.004
Arch culvert parapet, tow-path	2107.15	496.445	+.046	+1.525	498.016	.024	—17.386	.000
Snubbing post, tow-path	2125.90	511.094	+.028	+1.525	512.647	.029	+14.631	.000
Tuttle's bridge, east wing, tow-path	2152.	514.141	+.009	+1.525	515.675	.027	+ 3.028	.003
Stop-gate, west of Holley	2168.	510.921	+.010	+1.525	512.466	.027	— 3.209	.001
McGuire's bridge, east wing, tow-path	2191.54	514.192	+.012	+1.525	515.729	.028	+ 3.263	.000
Dive culvert parapet, tow-path	2250.80	504.368	—.004	+1.525	505.889	.025	— 9.840	.004
Hulberton bridge, west side, bottom step	2279.30	513.285	+.005	+1.525	514.815	.025	+ 8.926	.001
Dive culvert parapet, tow-path	2302.80	501.408	—.047	+1.525	502.886	.026	—11.929	.001
Snubbing post, tow-path	2340.20	511.054	—.042	+1.525	512.527	.029	+ 9.651	.003
Double arch culvert, east end parapet, tow-path	2369.92	502.308	—.043	+1.525	503.790	.028	— 8.747	.001
Brockville waste-weir, west wall	2369.92	510.471	— 043	+1.525	511.953	.028	+ 8.163	.000
Brockville bridge, east wing, tow-path	2384.46	514.391	—.048	+1.525	515.868	.026	+ 3.915	.002
Snubbing post, tow-path	2412.15	510.406	—.051	+1.525	511.880	.025	— 3.988	.002
Hindsburgh bridge, east wing, tow-path	2445.50	514.636	—.051	+1.525	516.110	.025	+ 4.230	.000
Snubbing post, tow-path	2521.32	511.420	—.046	+1.525	512.899	.026	— 3.211	.002
Dive culvert parapet, west wing, tow-path	2554.93	501.176	—.078	+1.525	502.623	.027	—10.276	.003
Jaqueth's bridge, east wing, tow-path	2567.27	514.881	—.079	+1.525	516.327	.032	+13.704	.002
Arch culvert parapet, near east end, tow-path	2615.60	501.656	—.086	+1.525	503.095	.029	—13.232	.003

Table of benches — (Continued).

DESCRIPTION.	Station.	Elevation by survey.	Correction for tests.	Correction for eastern and middle divisions.	Probable elevation.	Probable error.	Difference between benches.	Probable error in differences.
Bidsnell's bridge, east wing, tow-path	2623.63	513.721	—.076	+1.525	515.170	.034	+12.075	.005
Arch culvert parapet, near east end, tow-path	2688.50	501.445	—.075	+1.525	502.895	.035	—12.275	.000
Hall's bridge, west wing, tow-path	2742.44	514.736	—.053	+1.525	516.198	.041	+13.303	.006
Albion waste-weir, west wall	2763.	510.746	—.060	+1.525	512.211	.037	+ 3.987	.005
Ingersoll street bridge, Albion, east wing, tow-path	2791.15	511.489	—.057	+1.525	512.957	.034	+ 0.746	.000
Swing bridge, north-west corner pier, coping	2804.92	508.396	—.068	+1.525	509.753	.031	— 3.204	.008
Dive culvert, west end parapet, tow-path	2850.75	505.223	—.108	+1.525	506.640	.021	— 3.113	.000
Lattin bridge, east wing, tow-path	2892.20	514.350	—.098	+1.525	515.777	.026	+ 9.137	.005
Dive culvert, west end parapet, tow-path	2918.45	505.495	—.097	+1.525	506.823	.027	— 8.954	.001
Gaine's basin bridge, west wing, tow-path	2941.63	512.580	—.094	+1.525	514.020	.029	+ 7.197	.002
Dive culvert, parapet, 3 feet from east end, tow-path	2980.44	505.993	—.106	+1.525	507.412	.024	— 6.608	.006
Eagle harbor, waste-weir, west wall, tow-path	3041.70	509.852	—.107	+1.525	511.270	.022	+ 3.858	.001
Eagle harbor bridge, east wing, tow-path	3065.30	513.578	—.108	+1.525	514.995	.022	+ 3.725	.000
Starkweather bridge, east wing, tow-path	3102.50	514.722	—.102	+1.525	516.145	.025	+ 1.150	.003
Allen bridge, east wing, tow-path	3125.60	514 658	—.095	+1.525	516.088	.029	— 0.057	.004
Long bridge, east wing, tow-path	3164.70	514.661	—.133	+1.525	516.053	.026	— 0.035	.005
Center of dive culvert parapet, tow-path	3264.	508.452	—.120	+1.525	509.857	.027	— 6.196	.003
Knowlesville bridge, west side, tow-path	3310.	514.483	—.140	+1.525	515.868	.022	+ 6.011	.006
Dive culvert parapet, east end	3388.85	502.317	—.158	+1.525	503.684	.026	—12.184	.007
Road arch coping, east pilaster, tow-path	3437.60	502.930	—.152	+1.525	504.303	.029	+ 0.619	.003
Stop-gate abutment, tow-path	3447.	511.449	—.152	+1.525	512.822	.030	+ 8.519	.002
Beal's bridge, east wing, tow-path	3499.28	513.008	—.158	+1.525	514.375	.038	+ 1.553	.005
Hasting's bridge, west wing, tow-path	3562.93	514.259	—.177	+1.525	515.607	.047	+ 1.232	.010
Holloway's bridge, east wing, tow-path	3613.50	513.652	—.182	+1.525	514.995	.044	— 0.612	.002
North-west corner west buttress, Medina aqueduct	3633.78	511.504	—.182	+1.525	512.847	.044	— 2.148	.000
Medina waste-weir, east wall, berme	3638.50	511.462	—.182	+1.525	512.805	.042	— 0.042	.000
Medina bridge, east wing, tow-path	3644.28	513.169	—.186	+1.525	514.508	.045	+ 1.703	.001
Old stop-gate, center of abutment	3701.93	512.112	—.205	+1.525	513.432	.044	— 1.076	.001
Dive culvert parapet, tow-path	3739.87	509.366	—.216	+1.525	510.675	.044	— 2.757	.002
Jackson's bridge, west wing, tow-path	3801.18	514.056	—.229	+1.525	515.342	039	+ 4.667	.006
Shelby basin bridge, east wing, tow-path.	3854.63	515.703	—.268	+1.525	516.965	.036	+ 1.623	.010

Gorman's bridge, east wing, tow path	3914.07	515.612	—.255	+1.525	516.882	.040	— 0.083	.004
Coon's bridge, west wing, tow-path	3934.32	515.547	—.258	+1.525	516.814	.039	— 0.068	.001
Center dive culvert parapet, tow-path	4016.72	509.500	—.303	+1.525	510.722	.043	— 6.092	.009
Middleport bridge, west side, tow-path	4061.12	513.658	—.311	+1.525	514.872	.040	+ 4.150	.004
Middleport waste-weir, east abutment	4074.50	512.255	—.315	+1.525	513.465	.039	— 1.407	.002
Dive culvert parapet, west end, tow-path	4114.50	506.685	—.326	+1.525	507.884	.032	— 5.581	.006
Watson's bridge, west wing, tow-path	4182.55	514.515	—.349	+1.525	515.691	.021	+ 7.807	.011
Waste-weir, west abutment, near front angle	4200.70	512.310	—.359	+1.525	513.476	.016	— 2.215	.005
Hurd's bridge, east wing, tow-path	4307.37	514.714	—.310	+1.525	515.929	.027	+ 2.453	.013
Reynales' basin bridge, east wing, tow-path	4353.75	514.325	—.360	+1.525	515.490	.021	— 0.439	.014
Mabee's waste-weir, west abutment, berme	4422.	511.738	—.371	+1.525	513.892	.016	— 2.598	.006
Dive culvert, center of parapet, tow-path	4494.26	507.408	—.385	+1.525	508.548	.008	— 4.344	.007
Dive culvert, center of parapet, tow-path	4610.55	506.577	—.346	+1.525	507.756	.012	— 0.792	.011
Millard's bridge, east wing, tow-path	4722.97	518.751	—.336	+1.525	519.940	.017	+12.184	.005
Dive culvert, center of parapet, tow-path	4810.60	505.010	—.373	+1.525	506.162	.006	—13.778	.010
Dive culvert, west end of parapet, tow-path	4840.92	505.095	—.376	+1.525	506.244	.004	+ 0.082	.001
Comstock's bridge, west wing, tow-path	4923.91	517.374	—.367	+1.525	518.532	.010	+12.288	.005
Adams' street bridge, east wing, tow-path	4944.50	513.519	—.373	+1.525	514.671	.006	— 3.861	.003
Mill street bridge, east wing, tow-path	4960.20	516.000	—.377	+1.525	517.148	.004	+ 2.477	.002
Lockport waste-weir, east abutment, berme	4961.04	515.477	—.377	+1.525	516.625	.004	— 0.523	.000
East berme, hollow quoin, Lock 67, Lockport	4999.18	522.741	—.389	+1.525	523.877	.002	+ 7.252	.006
East berme, hollow quoin, Lock 71, Lockport	8.35	568.479	—.373	+1 525	569.631	.003	+45.754	.001
Eye bolt in rock ledge, tow-path	60.80	575.569	—.376	+1.525	576.718	004	+ 7.087	.001
South-east corner drop, culvert wall, 2d cor. from top	218.74	575.390	—.364	+1.525	576.551	.001	— 0.167	.006
Snubbing post	241.55	574.132	—.369	+1.525	575.288	.001	— 1.263	.002
Holley bridge, west side, bottom course, tow-path	320.	572.749	—.313	+1.525	573.961	.006	— 1.327	.013
East hollow quoin, Sulphur Spring guard-lock pier	414.32	579.251	—.330	+1.525	580.446	.002	+ 6.485	.008
Snubbing post	21.10	575.255	—.337	+1.525	576.443	.005	— 4.003	.003
West front angle foundation, old bridge abutment	63.	572.811	—.333	+1.525	574.003	.006	— 2.440	.009
Pendleton change bridge, east wing, berme	121.87	573.420	—.333	+1.525	574.612	.006	+ 0.609	.000
Snubbing post, west of Ransom creek bridge	267.13	575.328	—.333	+1.525	576.520	.006	+ 1.908	.000
East wing, New Home bridge, tow-path	353.80	574.048	—.315	+1.525	575.258	.003	— 1.262	.009
First post east of Pickard's bridge	477.50	573.175	—.340	+1.525	574.360	.016	— 0.898	.014
Nail in docking	580.	570.215	—.316	+1.525	571.424	.008	— 2.936	.003
Post 674 chains west of Bush's bridge	742.07	572.780	—.302	+1.525	574.003	.001	+ 2.579	.007
Square post, line of Curney's barn	866.60	573.538	—.304	+1.525	574.759	.002	+ 0.756	.001
South-east corner of Erie railroad, pier foundation	1027.42	568.846	—.313	+1.525	570.059	.007	— 4.700	.004
North-east corner of masonry, end of Tonawanda dam	1057.20	573.076	—.293	+1.525	574.308	.002	+ 4.249	.005
West wing of Main street bridge, tow-path	1050.90	574.305	—.300	+1.525	575.530	.003	+ 1.222	.002